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BUILD A LOW-COST NI-CD/NI-MH BATTERY CHARGER 15 **Fred Blechman**
Based on the Velleman "Low Cost Battery Charger Kit," this battery charger is for home and car use, and can be used to charge single rechargeable Ni-Cd and rechargeable Ni-MH batteries in AAA, AA, C, and D sizes.

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by Robert Nansel

Amateur Robotics

In Amateur Robotics, it's easy to get so absorbed with the many systems that must be thought out, built, and debugged to get a single robot working that we rarely look very far from our current labors. We are surrounded by gearmotors, batteries, scrap aluminum, wheels, wires, infrared sensors, microcontrollers, voltage regulators, keyboards, soldering irons, logic probes, and towering mounds of data books and printouts.

Every once in a while it's good to step up out of the trenches to look around at the robotics landscape as a whole, to see the horizon — both where we've been and the possibilities of where we might go. On the horizon behind, are the famed robot turtles built by Dr. W. Grey Walter over 50 years ago, and on the horizon ahead, are robots able to do anything an animal can do, perhaps anything a human can do.

Here in the middle with our wires and wheels, though, it's hard to see how we're ever going to bridge these horizons.

It's like this: No one who has worked with computer and robot technology can ignore the fact that computers advance significantly faster than robots. Computer hardware has gotten simpler and cheaper to produce even as it has become massively more capable, but robot hardware has advanced little in decades. Other than refinements in electronic sensor and digital control technology, the average amateur robot of 2001 is hardly different in capability than Walter's turtles.

Machina Speculatrix

Walter's Tortoises were about 12 inches high and 18 inches long, about average size for an amateur robot. Using vacuum tubes and relays — all that were available in England in 1948 — the robots sensed collisions, negotiated obstacles, interacted with light sources, and even returned to a "hutch" to recharge when their batteries ran low.

Walter's first two robots — Elmer and Elsie — behaved in such a life-like manner that he was moved to give them Latin species names: Machina Speculatrix — "Exploring Machines." Elmer and Elsie were followed by a second series of six machines of more robust mechanical design with the added feature of rudimentary learning (basically a capacitor memory element). Walter named them Machina Docilis — "Tameable Machines."

These robots, like Elmer and Elsie, used a tricycle drive design where the front wheel provided both drive and steering functions, while the two rear wheels were fixed casters. The photocell light sensor mounted on the front-wheel steering spindle, thus always pointing in the direction of the drive wheel. Two pentode vacuum tubes coupled together through RC networks formed a hybrid analog/digital neural network.

Photo 1: Symapod, a radially symmetrical hexapod robot.

I've included a few web links and other references about these remarkable robots. I would bet that most amateur robot designs to this day do not duplicate all the behaviors that M. Speculatrix was capable of. I'd say, if Walter's robots were made a few inches shorter and given fire extinguishers, they'd do a creditable job in the Trinity Fire Fighting contest (though they wouldn't win, not with the penalties they'd rack up for bumping into walls).

Rodney Brooks, incidentally, was heavily influenced in his thinking on subsumption architecture by reading about Walter's robot turtles. The whole BEAM robotics movement thus owes a debt to the pioneering research of W. Grey Walter.

Brittle Robots

It's not hard to understand why most robots have advanced little beyond M. Speculatrix and its cousins. Partly it's because our robots are — in broad ways — too much like live turtles — creatures not noted for speed, agility, or cleverness. The bigger issue is that, while computer technology available to today's robot builder is incomparably more sophisticated than M. Speculatrix's humble two-tube "brain," the electromechanical hardware has improved only slightly. Motors are a bit cheaper and easier to use than in Walter's day, solid-state motor controls are far better, and we have a wider variety of sensors from which to choose. But the basic fact remains that the mechanics of even the fanciest robots are still crude in comparison to the biological forms we would like our robots to emulate. Even turtles.

If budget and manpower were no obstacle and you could place a supercomputer aboard a robot base with a rich suite of sensors available today, including video cameras and

Photo 2: Symapod negotiating rough terrain.

all the AI software you pleased, the robot would still be limited by its own mechanics. It would be a "brittle" system because large portions of the robot – the chassis, actuators, wheels, drivetrain, etc. – would be dumb, insensate, having very few sensors and little mechanical flexibility, and unable to deal gracefully with the unanticipated.

Teeny, Tiny Tech

Most of the problems we have with brittle robots could be solved if we could routinely, cheaply, build tiny sensors and actuator systems right into the structures of our robots – indeed, even make our robots out of "smart" materials. Such robots would not get stuck under a chair simply because of the perverse fact of the universe that the rungs between the chair legs are always at precisely the height that our robots can't detect. If a robot made with smart materials did somehow manage to get wedged upside down in a tight space – maybe through the agency of an overenthusiastic toddler – it could use the actuators within its structure to change its shape enough to squeeze out of its predicament, acting more like a cat than a turtle.

It's conceivable that you could build robots with these features using existing micro-electromechanical system (MEMS) technology – essentially, electromechanical devices etched into silicon – but it would be extraordinarily expensive to do so because it would require that all the elements of the robot be built in a billion dollar silicon wafer fab. Because we're no longer talking about mere chips, but much larger mechanical and structural components, the yields would be abysmally low.

This isn't to say these problems couldn't be solved; after all, large

Resources for Walter Tortoises

Build your own M. Speculatrix using LEGO Mindstorms:
http://www.plazaearth.com/usr/gasperi/walter.htm

Download this simulation of M. Speculatrix:
http://www.nyx.net/~jpurbric/

A restoration and replication effort at Bristol:
http://www.ias.uwe.ac.uk/walterbot.html

W. Grey Walter Archives:
http://www.uwe.ac.uk/facults/eng/ias/gwonline.html

Holland, Owen E., Grey Walter: The Pioneer of Real Artificial Life, Proceedings of the 5th International Workshop on Artificial Life, Christoper Langton Editor, MIT Press, Cambridge, 1997, ISBN# 0-262-62111-8, pp 34-44.

Levy, Steven, Artificial Life, Vintage Books, 1992, pp 282-284.

Long, Eric, "American Heritage of Invention & Technology," Vol. 14, Number 4, Spring, 1999, Back Cover.

Walter, W. Grey, "An Imitation of Life," Scientific American, May 1950, pp 42-45.

Walter, W. Grey, "A Machine that Learns," Scientific American, August 1951, pp 60-63.

Walter, W. Grey, The Living Brain, W. W. Norton, New York, 1953.

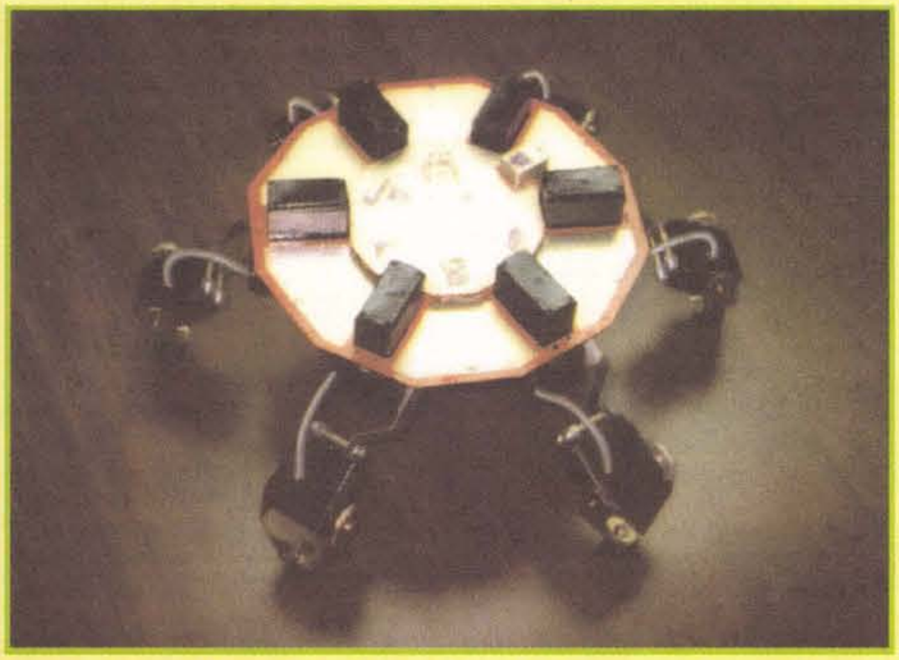

Photo 3: Topside of Symapod.

LCD displays faced much the same trouble with yields. Large LCDs are proof that we can build meter-scale macroscopic devices with usable microscopic features. But LCDs are also much, much simpler than equivalent arrays of MEMS sensors and actuators would be, and LCD displays are still quite expensive and responsible for more than half the cost of a laptop. Absent a major breakthrough in the cost and yields of MEMS fabrication techniques, I doubt we'll ever see MEMS-based smart materials deployed in any commercially significant numbers, and it certainly won't be cheap enough for the likes of you or me.

Teenier, Tinier Tech

The principles of physics, as far as I can see, do not speak against the possibility of maneuvering things atom by atom.

— Richard Feynman, 1959

Paradoxically, the solution to MEMS woes may well be to go toward technology with a characteristic feature size a factor of a thousand smaller than that of current micron-scale fabrication techniques. I'm talking about nanotechnology, or more accurately, molecular nanotechnology ("MNT," for short).

Alright, I know that some of you out there may now be rolling your eyes. As a fellow writer said to me a few months ago, "Nanotechnology is the technology of the future — and always will be." Most of you have probably at least heard the term, if only from old Star Trek: Next Generation episodes (where supposed nano-scale machines were called "nanites"), or you may have read articles about it in the popular press describing the wonders-to-be of nanotech — or why it's all bogus and will never work. Some of you may even have read one or more of K. Eric Drexler's various works: *Engines of Creation*, *Unbounding the Future*, or *Nanosystems*, just to name the books.

In these and other works, Drexler outlines a technology that builds from the perfect building blocks of nature: atoms. By using molecular-scale machinery to get essentially every atom in the right place, MNT can manufacture anything that is allowed by physical law, and do it cheaply, efficiently, and with no pollution.

Not only that, it could actually undo the environmental devastation wrought by centuries of using what Drexler calls "bulk" technologies. After all, what is pollution but atoms that show up in the wrong places?

It's hard not to write breathless superlatives when talking about MNT, a technology that has credibly been projected as able to solve just about every material problem in the world. Diamond fibers a hundred times stronger than steel and supercomputers the size of bacterium alone would transform the world.

Such things would certainly allow us hobbyists to make some pretty spiffy robots, even though diamond fibers and bacteria-scale computers are child's play with molecular nanotechnology.

Okay, if you've never heard of molecular nanotechnology, or if you've never read up on it, it can be hard to see how such things could ever be possible. If you have read *Engines* or *Unbounding* you may already be a true believer — because you want it to be true, because it sounds very, very attractive. Or, having read a little, you may be a profound skeptic, because it sounds too good to be true, there has to be a catch.

Whatever the case, to make an informed judgement about the

Resources for Nanotechnology

Foreign Institute

Started by K. Eric Drexler and Chris Peterson, "Foresight Institute's goal is to guide emerging technologies to improve the human condition. Foresight focuses its efforts upon nanotechnology, the coming ability to build materials and products with atomic precision, and upon systems that will enhance knowledge exchange and critical discussion, thus improving public and private policy decisions." They publish the newsletter Foresight Update for members. **http://www.foresight.org/**

Foresight Guidelines on Molecular Nanotechnology

Proposed guidelines to promote safe development strategies and peaceful, environmentally-responsible uses of nanotechnology. **http://www.foresight.org/guidelines/current.html**

The Institute for Molecular Manufacturing (IMM)

A nonprofit foundation that carries out research aimed at developing molecular manufacturing (molecular nanotechnology). **http://www.imm.org/**

National Nanotechnology Initiative (NNI)

The government is putting up $497 million to foster the emergence of molecular nanotechnology and nano-scale science. **http://www.nano.gov/**

Zyvex

Billed as the "World's First Nanotechnology Startup."
http://www.zyvex.com/nano/

Feynman's classic 1959 talk "There's Plenty of Room at the Bottom"

http://www.zyvex.com/nanotech/feynman.html

***Nanosystems: Molecular Machinery, Manufacturing, and Computation*, by K. Eric Drexler (Wiley 1992).**

The textbook of molecular nanotechnology.
http://www.zyvex.com/nanotech/nanosystems.html

***Nanomedicine*, by Robert A. Freitas**, is an ambitious technical introduction to medical applications of nanotechnology. Nanomedicine is projected to run several volumes, but Volume I is available in print now. The text of Volume I is also available online at **http://www.nanomedicine.com/**

***Engines of Creation: the Coming Era of Nanotechnology*, by K. Eric Drexler (Anchor 1986)** discusses both the technology and its possible applications and consequences.

HTML version of *Engines of Creation* at
http://www.foresight.org/EOC/

***Unbounding the Future: the Nanotechnology Revolution*, by K. Eric Drexler, Chris Peterson and Gayle Pergamit (Quill 1991)**

A non-technical discussion of feasible future technologies through scenarios that illustrate the possibilities of nanotechnology. HTML version of Unbounding the Future at
http://www.foresight.org/UTF/Unbound_LBW/index.html

***Prospects in Nanotechnology: Toward Molecular Manufacturing*, edited by Markus Krummenacker and James Lewis** (Wiley 1995) has chapters by 15 different authors providing multiple perspectives on the field.

***Nano!* by Ed Regis (Little, Brown 1995)** is about the researchers involved in nanotechnology, particularly Drexler; it speaks on the history of the concepts behind nanotechnology as they developed from the 70s through the early 90s, and the varied reactions of the technical community to nanotechnology.

***Nanotechnology: Molecular Speculations on Global Abundance*, edited by BC Crandall, (MIT Press, 1996),** is a series of articles by several authors on what nanotechnology might be used for in the future.

sci.nanotech, net news discussion group covering molecular nanotechnology and allied fields.

Nanodot, the daily newspaper of nanotechnology. The site uses the open-source software Slash, familiar to thousands of Slashdot readers.
http://nanodot.org/

National Science Foundation nanotechnology database:
http://www.itri.loyola.edu/nanobase/

Nanotechnology papers and sci.nanotech archives, maintained by J. Storrs Hall, moderator of sci.nanotech
http://nanotech.rutgers.edu/nanotech/

An Overview of Nanotechnology
http://nanotech.rutgers.edu/nanotech/FAQ.html

Sean Morgan's nanotechnology page
http://www.lucifer.com/~sean/Nano.html

Brad Hein's Nanotechnology Site
http://www.nanosite.net/

Nanotechnology Industries, maintained by Gina "Nanogirl" Miller
http://www.nanoindustries.com/

NanoLink

Key Nanotechnology sites on the Web
http://sunsite.nus.edu.sg/MEMEX/nanolink.html

UCLA's chemistry page

Many links to chemistry-related topics
http://www.chem.ucla.edu/chempointers.html

prospects of MNT, you really should get a copy of the third book, Drexler's own PhD thesis published as *Nanosystems: Molecular Machinery, Manufacturing, and Computation*, by K. Eric Drexler (Wiley 1992, ISBN 0-471-57518-6).

In *Nanosystems*, Drexler lays out the foundations of the field in extraordinary, compelling detail. You simply cannot understand the likelihood of MNT being developed — or how close to it we really are — without reading this book. I've also included a sidebar with the best-of-the-best of the galaxy of information out there on the web and in print.

If you still don't believe MNT is possible after you've read the *Nanosystems* and the other sources, then by all means, write a note to me explaining why you have come to this conclusion. Drexler and many other researchers would love to have somebody finally punch a definitive hole in the scheme.

Nanosystems has been out for most of a decade, and the basic ideas of nanotechnology have been around for more than two decades; in that time, not one scientist or technologist has been able to knock them down. There are doubters aplenty, but the closer people look at Drexler's proposals, the more likely they are to become convinced he's right.

In fact, the biggest controversy now seems to be not whether MNT will be developed, but how soon. Doubters tend to say 50 to 100 years, believers say 10 to 20.

Foresight Conference

There's no better way to get a feel for where nanotechnology is at and where it's headed than to attend the Foresight Institute's Foresight Conference, now held yearly. All previous conferences have been in California, but this one was held in Bethesda, MD — close enough for me to drive — so I finally got to attend. Next year, it will be back in Palo Alto, CA, but the Foresight Institute people tell me the conference will probably alternate coasts from now on.

The conference was held from November 3rd through the 5th, 2000, with an optional tutorial session on the fundamentals of nanotechnology held the day before on the 2nd.

The conference was fairly pricey at $550.00 for early registration (including lunches), with another $450.00 for the tutorial, which I elected to skip. Full-time students could get into the conference for as little as $95.00 (without the lunch), but the tutorial was the same price.

There were over 30 talks spread over three very full days, covering topics ranging from nano-scale surface science to biological nanodevices, from molecular scale electronics to the sliding and rolling resistance of carbon buckytubes over diamond substrates. I have to admit that at least 70% of the talks went clean over my head, and the remaining 30% left me dazed. And delighted. Stuff is really happening

I didn't attend the tutorial, though I heard glowing reports about it from some who did. One young woman, a freshman in college in Ohio, saved all summer — and even sold her car — to be able to afford the tutorial and the conference. She's studying material science and wants to specialize in nanotechnology applications. I predict she will go very far.

This was the Eighth Foresight Conference on Molecular Nanotechnology, and it had a record international turnout of over 400 nanotechnology researchers, funders, and numerous venture capital firms, a first for this nascent industry. There were about equal numbers of blue jeans and suits, a change, I gather from the past when blue jeans predominated.

Photo 4: Note different leg postures.

Aside from the conference itself, the big deal here was the Feynman Prize in Nanotechnology, named in honor of the late Nobel physicist Richard Feynman. Nanotechnology's highest honor, the Feynman Prize this year was awarded to researchers at Georgia Tech, HP Labs, and UCLA for significant advances in building useful devices and structures with atomic precision. Two $5,000.00 prizes are given each year, one for theoretical work and one for experimental achievement.

This year's prize in Theoretical Nanotechnology went to Georgia Tech physicist Uzi Landman for his pioneering work in computational materials science for nanostructures. Since we can't construct nanomachines today — we don't yet have proper nanomechanical tools — computer modeling is essential in predicting what could be built at the molecular level when we finally do have the right tools.

The Experimental Prize went to the multidisciplinary team of chemist R. Stanley Williams and computer scientist Philip Kuekes, both of HP Labs in Palo Alto, along with chemist James Heath of UCLA. They built a molecular switch, a big step toward their eventual goal of building memory chips just 100 nanometers wide, smaller than a bacterium.

At the Feynman Awards banquet, they recalled how, in the beginning of their collaboration, their different technical backgrounds caused much mutual confusion, because of differing approaches, assumptions, and even such mundane things as different professional vocabularies. "We sometimes spent hours and hours in the office, and at the end the day we'd emerge with nothing but a common noun."

That's been my experience in general with robotics, multidisciplinary field that it is. Usually it's not difficult to do a particular thing outside of your own specialty if you can just find someone else who knows how. But to do that you often have to find

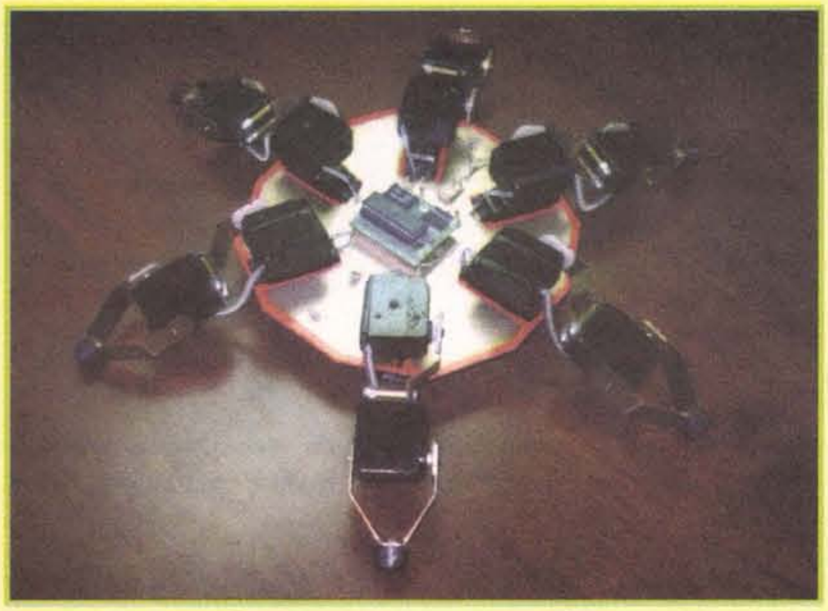

Photo 5: Bottom view of Symapod.

out what you want to do is called in that specialty. Common nouns, though small things, are important.

Symapod: Robot of the Month

Pulling back from both the humble history and the brilliant future of robotics, I want to show off a robot project I came across on the web recently, a hexapod walker with a difference. The robot was built by Colin MacKenzie. Colin lives and works in Nova Scotia and was kind enough to send me some photos of his machine (see Photos 1 through 5).

I'll let Colin tell you about his robot:

"Symapod, short for 'symmetrical hexapod,' has its legs oriented in a star configuration with no obvious front or back to the robot. It weighs 1.25 Kg. I had previously made a traditional-style hexapod with three legs on each side. It had only two DOF per leg and used a total of 12 standard servos (without my digital servo controller board). I found having the extra servo — an extra DOF in each leg — gave much better control and increased speed. My first robot walker stumbled along somewhat — I called it 'Twitchy' because it was so unsteady; part of that was due to the unpredictable response of the unmodified servos.

The major goal of Symapod was to test digital servo controllers I've designed, to see if these controllers would make it easier for the robot to adapt to rough terrain and obstacles. Symapod can level itself where Twitchy would become tipsy if going over uneven terrain. Twitchy used a hard-coded tripod gait that didn't adapt. In fact, it couldn't even perform a turn.

It was as I was thinking of how to incorporate the turning algorithm into Twitchy that I came up with the idea of the symmetrical hexapod. I realized that the solution of turning would be so much easier if the robot was symmetrical. I was correct: the walking algorithm was child's play. A few people have supposed the algorithm would be complex because of its symmetry, but that wasn't the case.

The entire robot remains a work in progress, but I have had it walking around quite successfully! I am fine-tuning its adaptation now.

This symmetrical configuration allows it to instantly travel in any direction without turning or re-orientating its body. Furthermore, the symmetrical design also simplified the walking algorithm and made it more adaptive than traditional six-legged robots. The walking algorithm was a combination of a state machine, simple geometry, and a static neural network. Programming the walking algorithm was by far the easiest part of Symapod's construction, taking only two days work for its first steps.

The base of the robot is the printed circuit board (PCB) itself and has remained strong without reinforcement. The PCB contains Symapod's sensors and a Z180 running at 9MHz as the master onboard controller. The robot is tethered to a desktop computer using an RJ45 type connector from which it receives power and high-level commands.

Symapod was designed for eventual travel over uneven and rough terrain with each leg boasting three DOF, for a total of 18 R/C servos, each modified with a custom-built digital servo controller. With a digital replacement servo controller, each servo can relay the detection of obstacles and force feedback to the master controller. The digital servos use the popular I2C bus protocol and allow a walking algorithm that adapts to varying terrain.

The legs are made of the servos themselves coupled together with bent brass strips available in hobby shops. Mechanically, it's a simple design that remains strong and easy to manage. I've made my best effort to keep as few wires showing as possible and have used lightweight compression springs to cover wires leading from each of the servos. The springs keep the wires from wearing or tangling and increase the overall aesthetic look of the robot."

[Colin MacKenzie may be contacted at: E-mail: robots@colinmackenzie.net Web: www.colinmackenzie.net]

Next Time

I begin cutting metal on Heavy Iron, my hobbyist CNC mill/drill machine. This project is going to absorb large portions of my next several columns, so buckle in and get your hacksaws, drills, cold chisels, and files ready to go! I'll also have some Jiffy coverage, another Robot of the Month pick, a peek at my efforts at melting aluminum, and much more. I can tell already, this is gonna be one great year! **NV**

If you have suggestions, questions, or comments about amateur robotics topics, you can now reach me at:

Robert Nansel
Box 228
Ambridge, PA 15003

Email: bnansel@nauticom.net

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It'll make you More Popular
Friends will be stopping by with their Music & Data CD's begging you to make copies. The ease and convenience of the Dual CD & CD Recorder makes copying CD's easier than ever before. Just press a single button and walk away. That goes for Floppies too. You'll tell your friends what this machine does but they won't believe it. They'll be coming by to see it for themselves. They'll go back to their whimpy machine and wish it did half of what yours does. It's all that and more. Fastest Computing speed, Fastest Video Speed, Supports ALL Maximum Video Resolutions Ever Created. Years from now you'll find it easy to upgrade every single feature of this machine. The only Tower with a lighted face.
Wow ONLY $1299 500 Mhz Version
Wow ONLY $1499 900 Mhz Version
Compare Anywhere, Beats ANY Machine & Made with Top Brand Components
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reader FeedBack

Dear Nuts & Volts:

Thanks for finally including an article on the HC11, by Al Williams and please continue to print more in the future.

By the way, it's a whole lot easier to deal with the HC11 if you purchase the HC11 EVBU which is the Motorola evalution board unit. It comes with an 'E9 and is a snap to connect with other projects with the built-in header on the board, plus all the manuals are included.

Denis Casserly
Canada, Vancouver, BC

Dear Nuts & Volts:

Regarding the Nov. 2000 Electronics Q & A column, "Time Is On My Side," it's only a matter of time before the garage door closes while a car, wheelbarrow, child, or other object is located at the wrong place at the wrong time when the door closes. You need — at least— to add a circuit to detect such an object, and override the timer. Even if such a safety interlock were used, I think the concept altogether is a poor one. Close the door before you leave the house!!

C. Stillhard
Frenchtown, NJ

Dear Nuts & Volts:

In the Oct. 2000 issue on Page 49 is "3rd Place A PIC_ISA Control Board (sample application: a stand-alone web cam) entered by Dr. Edward Cheung." Is there any further information on this device — specifically the PIC-driven ISA slot board? I would really like to use it for a data logger, using a standard disk drive controller card.

Karl Liebau
via Internet

Response:

Further information on the PIC-ISA Control Board, including a foil pattern, can be found at www.expresspcb.com/Projects/PicIsa/PicIsa.htm and http://members.bellatlantic.net/~echeung/awards/pic2k/pic2k.htm.

TJ Byers
Q & A Editor

It is with sincere regret, we must inform our readers of the unexpected death of Joe Carr. Joe passed away November 25th at his home. Joe was well-respected and will be missed tremendously.

There will be one more Open Channel column that Joe had finished, which will complete his two-part series on fiber optics.

SPECIAL NEWS REPORT

Cable Industry Dragging Its Feet

In its status report to the Federal Communications Commission (FCC) regarding cable compatibility agreements between the consumer electronics and cable industries, the Consumer Electronics Association (CEA) stated that manufacturers are unable to build cable-compatible digital television (DTV) receivers because of incomplete cable industry standards. According to the statement submitted to the FCC, the cable industry has yet to complete a number of essential standards, including that for the pod-host interface. CEA also expressed concerns about the cable industry's implementation of its February commitment regarding provision of program system information protocol (PSIP) data.

The point-of-deployment security module (POD) will allow consumers to access cable services without the use of a set-top box, using a security card supplied by their cable provider. CEA indicated that because the cable industry has not finalized standards for the POD, manufacturers are unable to build sets that incorporate this technology. In addition, the POD demonstrated by CableLabs is not capable of descrambling programming while supporting electronic program guides and other essential functions in the television receiver.

CEA also expressed concerns about the cable industry's progress on commitments to pass through PSIP information to cable-compatible DTV receivers. PSIP information is necessary to allow for the operation of electronic program guides (EPGs) and channel tuning features built into television receivers.

CEA cautioned that cable development and interpretation of proprietary protocols and technologies was rapidly outpacing the development of open standards. CEA warned that the cable industry may have powerful economic incentives to maintain exclusive control over the electronic program guide and other features that until now have been exclusive to the cable-supplied set-top box.

CEA urged the FCC to promote an inter-industry standards process and set firm timelines for cable completion of specifications necessary for interoperability. In addition, CEA asked the Commission to incorporate the completed compatibility standards into its rules.

"Half of all cable viewers prefer to connect televisions directly to their cable systems without the need for a set-top box. We urge the cable industry to finalize standards that manufacturers can build to as soon as possible, so that American consumers can enjoy the full benefits of cable compatibility," stated CEA Vice President of Technology Policy, Michael Petricone. "In addition, cable must move forward on PSIP implementation so that consumers can make full use of all their DTV product's features."

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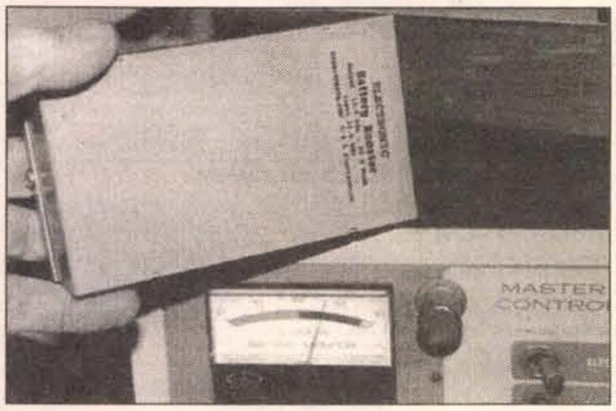
USEFUL PRODUCT REVIEW



Hook the battery booster close to your main battery voltage source and then hide it away in a ventilated area.

by Gordon West

VOLTAGE BOOSTER

Many high-frequency mobile installations sound terrific when the vehicle is running, but after a few minutes of vehicle turn-off, the transceiver begins to "fracture" at voice peaks. This is a common problem with the modern HF mobile transceiver that needs a minimum of 12.3 volts to sound good.

"The usual radio voltage requirement is specified as, 13.8 volts DC, ±15 percent. At minus 15 percent, the radio on full power transmit may go into distortion below 11.7 volts," comments Leo Lehner W4RRY. "And guess where this voltage is measured — right at the radio's power input point, and measured at full transmit peak power output," adds Lehner.

"High-frequency distortion is sometimes common in maritime mobile installations where a bunch of sailors haven't seen the sun for several days to charge up their solar-powered batteries," comments 40-meter net controller, Tom Barnum AA6TP. "Worse yet, the mariner can't see that they are distorting just by looking at the power output meter, either," adds Barnum.

Boaters are also plagued with wiring runs that may put their transceiver far enough away from the ship's bank of batteries that there could be up to a 1-1/2 volt drop in the factory-supplied power cord. Same thing in vehicles — if you tap off of the vehicle's fuse block, chances are you may also encounter a couple of volts drop when you modulate the equipment at 100 watts.

And for solar-powered field days, those big 17 amp hour emergency power packs may quickly pull down to 10 or 11 volts on transmit voice peaks, and this again will lead to transmit distortion.

Leo Lehner W4RRY, seems to have solved the problem of these voltage drops with a homebrew voltage inverter booster that he is now cranking out for hams, boaters, and pilots.

The inverter is pulse width modulated to vary the output power so as to continuously get a regulated 13.5 volts DC, even though the battery supply voltage may be as low as 11 volts. The device is designed to make up the two-volt loss in automobile, marine, or portable cables when there is no charging circuit on line.

The battery booster comes with three cables attached to the box — everything is completely assembled. One cable is red and is fused with a 20-amp, 3 Ag, fast blow regular fuse, and has additional wiring and a ring-type, solderless terminal. This is the lead that goes to the battery.

A black lead is connected to the negative post of the battery. His instructions say to hook the red and fused red wire up to the battery, and expect a small spark as the capacitors charge inside the box.

Next, locate the red cable without the fuse, and see that it has exactly 13.5 volts and the red lead is positive to the black lead. Your radio-fused red lead hooks up to this red lead, and your radio black lead needs to go to the negative post of the battery. Your radio ground goes to the chassis of your vehicle, or to sea water ground aboard a boat. For land use, your radio ground is earth.

In his testing at a recent ham radio show in Flagstaff, AZ, you could see the battery side of the circuit fluctuating down to 11 volts on one meter, yet the radio side of the circuit holding steady at 13.5 volts. The little box gets warm as it's doing its job, but it is designed for SSB or CW intermittent operation at 100 watts output, approximately 15 to 18 amps transceiver current. This inverter is specifically designed for non-continuous, high-frequency transceivers, so operation like 10 meters FM, or PACTOR should be avoided in that it will ultimately blow the 20-amp fuse.

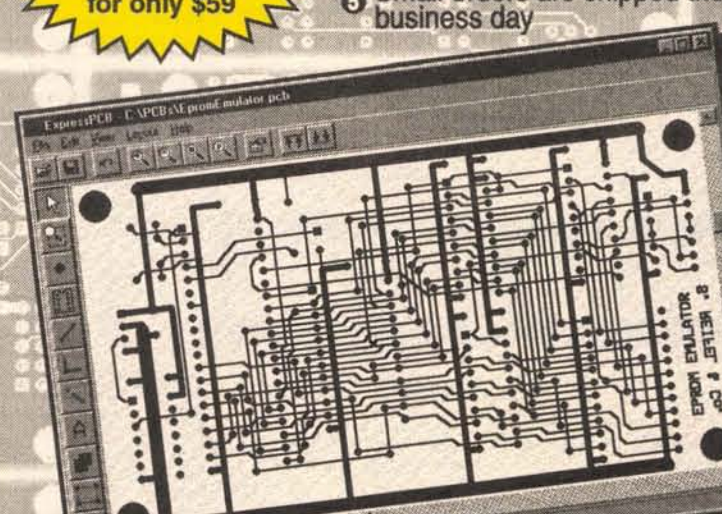
The battery booster uses a switching type circuit to generate the missing two volts. This type of circuit could make a lot of noise on high frequency because of the sharp squarewaves, and this noise could be generated all the way up to 50 MHz. He has designed filters in the battery booster, and we were not bothered with noise at all in several mobile and mobile marine installations.

"If you are an RVer, my battery booster is a necessity because of long power cable runs," comments Lehner. "I have made heat and cold runs, and the unit seems to work quite well below a 50-degree Centigrade case temperature. I have installed it in one of my Jeeps, and it still runs at 70-degrees Centigrade case temperature, almost too hot to touch. If you plan to do a lot of talking on HF, just be sure and mount the voltage booster where it can get a little bit of ventilation," adds Lehner.

He says you can also use this in the vehicle's accessory receptacle — you know, what we used to call the cigarette lighter receptacle. He says that newer cars now have a heftier lead feeding this receptacle, and it should work okay as long as your battery is in reasonable shape.

I have been using it continuously at my station to run my HF net rig that receives voltage only from photo cells on the roof. Even though I see my battery voltage dipping to below 11.5 volts, the voltmeter on the radio end of the circuit holds steady at 13.5 volts DC.

For under $90.00, it is working as designed. Contact Leo Lehner W4RRY, 5811 E. Crocus, Scottsdale, AZ 85254, or www.w4rry@fastq.com. **NV**



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Veeder Root type C342-0464. Industrial quality unit will accumulate & display pulses received on the count input terminals. Capacity is 8 digits.The reset terminals or the front panel can be used to clear the count. The front panel can also be disabled. Configurable as low speed (30Hz filter) or high speed (up to 7.5KHz) NPN or PNP input via the front panel. Designed for panel mounting the required opening is 22mmH x 45mmW. Depth behind panel 32mm. 1/32 DIN bezel. Character height is 7.6mm. Logic: Low <1V, High >2V, Width 70uS. minimum. Max. input 30VDC. Power source: Internal lithium battery with expected life of 7 years. Ltd. Qty. Reg. >$70ea. **Special, VEEDER-342...$24.00ea. 2 for $45**

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NEW YEARS SPECIAL, GM-200KPH....$59ea.
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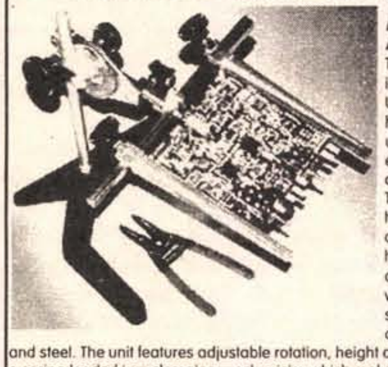
VIDEO SYSTEM DOME HOUSING, 14" DIAMETER with manually adjustable PAN AND TILT MOUNT.

This is an industrial quality unit from Sensormatic. Can be mounted in a dropped ceiling with our accessory panel. The Clear acrylic dome covers a black inner dome which hides the electronics within form prying eyes. There is a cutout for the lens to view the outside world. These are brand new in the manufacturers boxes. Overall size is Approx: 14"H x 14"Diameter. ORIGINAL COST: >$375ea. LTD. QTY,

NEW YEARS SPECIAL, S-DOME.....$39ea. or 2 for $69

PC BOARD WORK HOLDING STATION is FULLY ADJUSTABLE and "WICKED NICE"



TECHNICAL DEVICES Type, MARK III.

These are new, industrial quality and US made PC board holding fixtures for use during any electronic assembly or re-work operation. They are of the highest quality construction with a heavy powder coated steel base. All working parts are smooth, bright, clear coated aluminum and steel. The unit features adjustable rotation, height and angle as well as a spring loaded jam clamping mechanisim which makes changing boards repetitively a snap. A second spring loaded mechanisim makes it possible to instantly flip the board to the other side and back again without loosing any of your position settings. This is a pro unit. Overall size is: 8.75"W x 9"H x 12.5"D. The max board width is 8.5". ORIGINAL COST: >$95ea. LTD. QTY,

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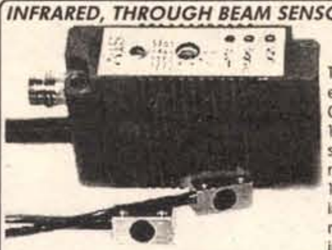

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GM410, less lens..HOLIDAY SPECIAL.....$149

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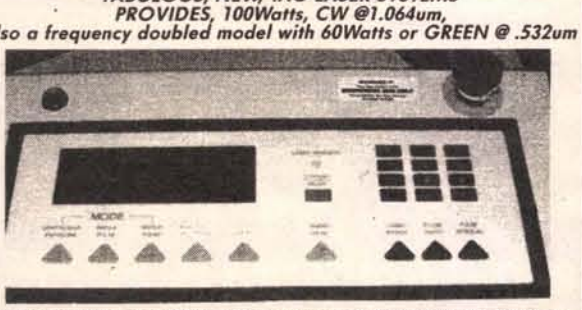

Laser Photonics Type: YCO-1003M, adjustable output power from 100mW to 100Watts ± 2%. Modes include: CW, Single pulse adjustable from 0.1 to 9.9 seconds in 0.1 sec increments. Repeat pulse with adjustable duration as previous and adjutable rate from 0.1 to 9.9 seconds in 0.1 sec. increments. Beam delivery via a 4 meter length quartz fiber optic. Internal fiber calibration system. LCD control panel for easy setup. Frequently used program settings can be saved to memory. Internal graphics printer. Pulsed laser diode aiming laser. Two stage microprocessor system monitoring. Key switch access with foot switch laser activation. Internal liquid to air cooling. Power required: 220VAC, single phase @40A, 60Hz. Mechanical: 38"H x 33"W x 22"D, weighs 325lbs., Wheel around cabinet. The Dual mode system in addition to the YAG specifications above includes frequency doubling on demand. The green output is Q-switched at 10KHz producing an output beam of 6mJ @ 200ns or 60W average with 2 to 40 watts delivered at the fiber. Pulse mode operation for the dual mode is different as well: Single pulse mode is adjustable from 0.1 to 600 seconds in 0.1 sec. increments. Repeat pulse mode has the same adj. pulse width and an adjustable pulse interval of 0.1 to 9.9 seconds in 0.1 sec. increments. These numbers apply to the 1.064 wavelength only. Cabinet size: 40"H x 33"W x 23"D weight 500lbs. Both models are NEW. Must ship via truck.

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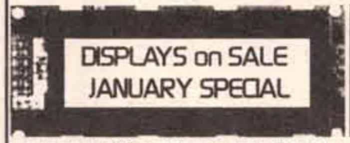

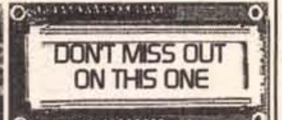

First, (shown left) from Solomon, the LM1140-SYLU, arrangement of 5 x 7 dot matrix characters 2.95mmW x 5.56mmH with cursor. COB driver with 8 bit parallel interface. Module size: 85mmW x 36mmH, Viewing area: 63.5mmW x 15.8mmH. with data. **Brand New.**
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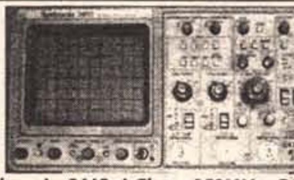

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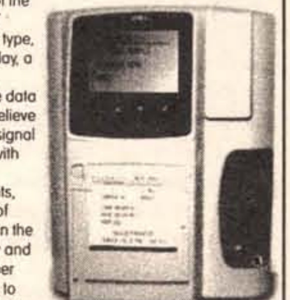

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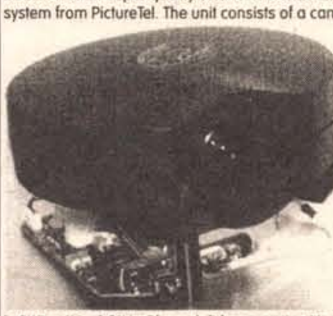
Another super quality color conference camera designed as part of a high end system from PictureTel. The unit consists of a camera head attached to a base PC board.



The attachment is via a moveable mount. There are two tiny stepper drives which create the pan and tilt motion. The tilt stepper is mounted to the PC board.The pan stepper is unmounted and attaches to the side on your base or enclosure. We assume the camera is controllable via serial commands however we have no info on how to do it. Anyone who can tell us can have some free cameras. The camera module specs: 400 lines @ 1lux, the power required is 12VDC @ 500mA. size of head is: 5.5" diam. x 3.2"H, The attached PCB is 3W" x 4L" x 1.3"H. Oh, and did we mention it's auto focus and auto iris too? Composite video output. We think it has Y/C also. Check our web site for further details as they become available. Order now, the price goes up when we get the serial commands. Removed and tested. **HOLIDAY PRICE, R2D2....$129ea. or 2 /$249, or 5/$499**

Write in 136 on Reader Service Card.

Build a Low-Cost Ni-Cd/ Ni-MH Battery Charger

by Fred Blechman

A toggle switch and binding posts for an external meter are mounted in the front of the box.

This battery charger — for home and car use — will be built to charge single rechargeable nickel-cadmium (Ni-Cd) and rechargeable nickel-metal-hydride (Ni-MH) batteries in AAA, AA, C, and D sizes. Based on the $12.00 Velleman "Low-Cost Battery Charger Kit," a few simple modifications will add considerable versatility.

We'll also cover how to test and rejuvenate nickel-cadmium batteries that appear to be dead.

This compact design can transform an AC-to-DC wall adapter or a DC car cigarette-lighter adapter into a charger for separate single-cell rechargeable batteries used in many electronic devices, from toys to cameras and flashlights.

Although the Velleman kit may be powered to charge Ni-Cd or Ni-MH batteries from 1.2 to 12 volts, you'll find any battery above a single 1.2 volts is a series combination of several cells, and may not be rechargeable if any of the cells are shorted internally — a common problem. It is usually difficult to determine the "bad" cell or cells in a dead battery pack, and while the battery pack may charge, a pack that has discharged prematurely will do so again!

I recommend you build this battery charger to charge single cells, and the rest of this article will assume you do just that. With the proper selection of a couple of resistors, you can tailor the charger to whatever charging rate you desire.

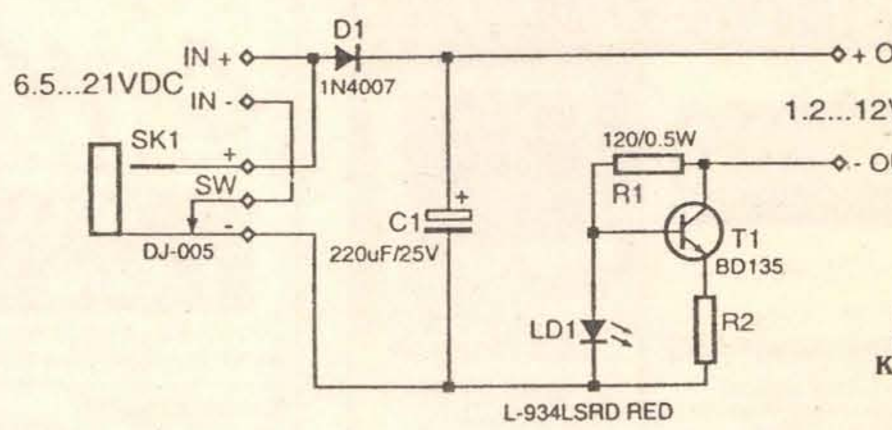


Figure 1 - Schematic of the Velleman K7302 Low-Cost Battery Charger.

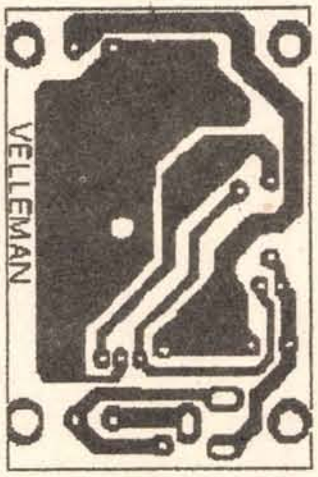


Figure 2 - Velleman K7302 printed circuit board layout.

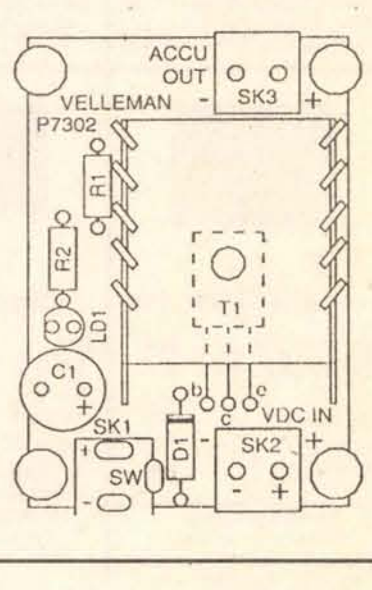


Figure 3 - Velleman K7302 parts layout.

Rechargeable Batteries

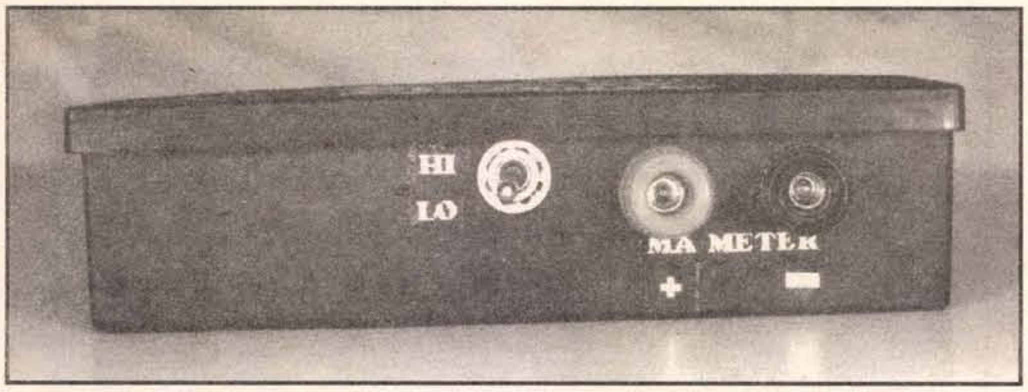
There are many types of rechargeable batteries, each with its own characteristics and charging requirements. The charger to be described here is designed to slow- or fast-charge nickel-cadmium batteries, and slow-charge nickel-metal-hydride batteries.

Typical rechargeable battery capacities are rated in "milliampere-hours," abbreviated mAh. For example, 600 mAh means a capacity of supplying 600 milliamperes of current for one hour, or any combination of milliamperes and time that multiplies to 600, such as 300 milliamperes for two hours.

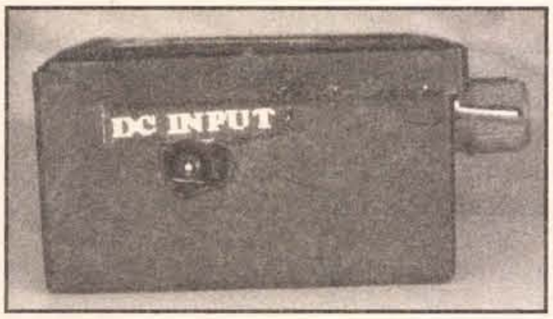
Be aware, however, that not all electronic devices will operate properly on removable rechargeable batteries. The voltage of a fully-charged nickel-cadmium or nickel-metal-hydride battery per cell is usually around 1.2 volts, rather than the typical 1.5 volts of a carbon-zinc or alkaline battery.

Ni-Cd Batteries

Nickel-cadmium batteries (commonly abbreviated as NiCd, Nicad, Ni-Cad, or Ni-Cd — we'll use



A toggle switch and binding posts for an external meter are mounted in the front of the box.



A small hole in the side of the box allows an external power plug to mate with the charger input jack.

"Ni-Cd") have been around for years, and can be found in many portable electronic devices. However, they tend to self-discharge when not in use, have a so-called "memory effect" that tends to keep them from fully charging, and have lower voltage even when fully-charged as compared to regular carbon-zinc or alkaline batteries.

If you are like me, you have a bunch of discharged Ni-Cd batteries around. Some won't accept a charge, others don't stay charged long. Most of these can be salvaged using the technique I'll describe, and with the simple modifications I've made, Ni-Cds can be slow- or fast-charged with this charger.

Ni-Cd batteries sold by RadioShack have typical mAh capacities as shown in Table I.

Ni-MH Batteries

The "new kids on the block," nickel-metal-hydride batteries (often abbreviated as NiMH, Ni-MH, or Ni-Mh — we'll use "Ni-MH") generally have greater capacity, and fully-charge without memory effect.

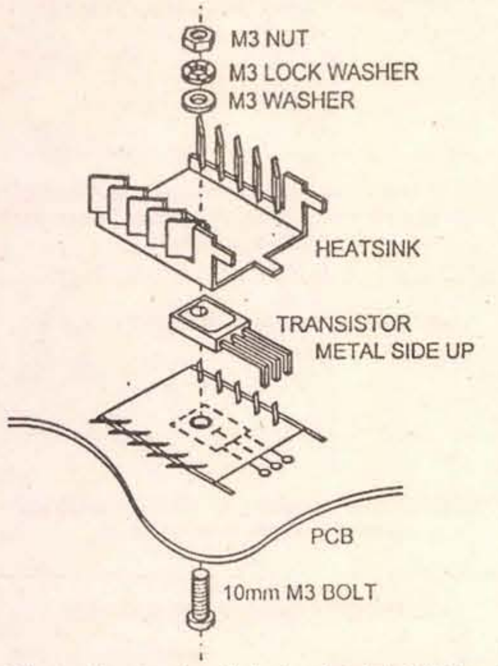
Ni-MH batteries can be damaged from heat by overcharging. But they can be safely slow-charged with this device from 500 to 1,000 times without the need to discharge them first to eliminate the memory effect.

Ni-MH batteries sold by RadioShack have typical mAh capacities as shown in Table II.

Theory of Operation

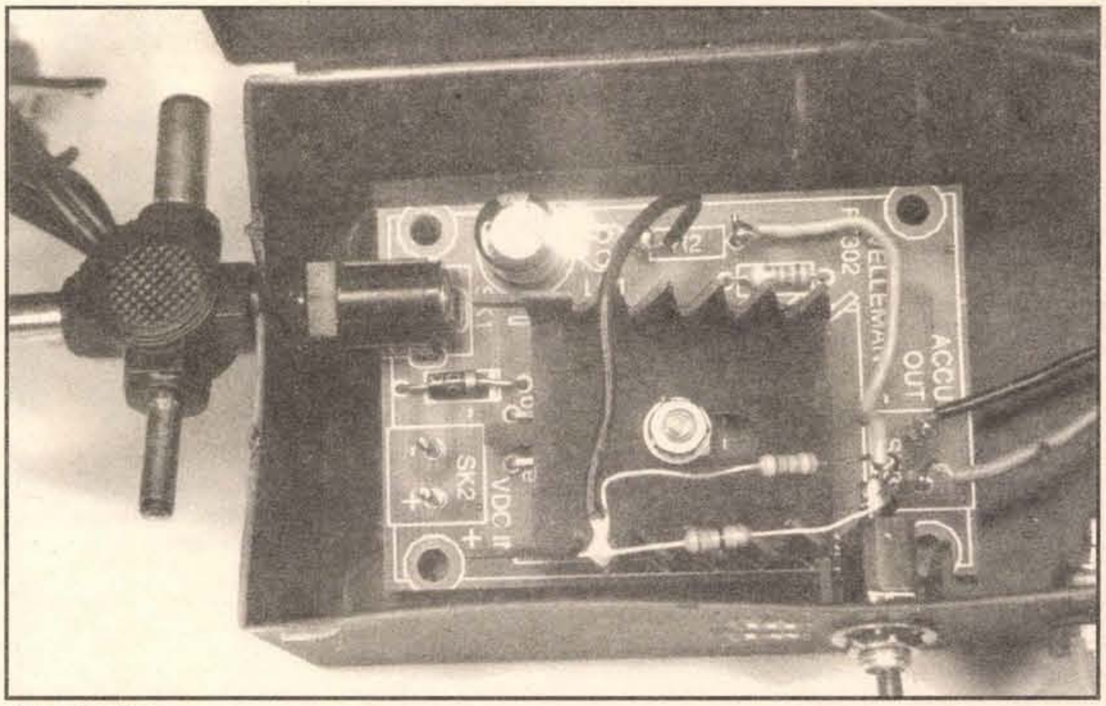
Figure 1 is the schematic for the Velleman K7302 "Low-Cost Battery Charger." A DC voltage of 6.5 to 10 volts is introduced into adapter socket SK1 or at the IN+ and IN- terminals, observing polarity. Note that SK1 includes closed-circuit switch SW, so if no adapter is plugged into SK1, IN- power is still connected to the circuit.

The battery to be charged is connected to the +OUT and -OUT terminals, observing polarity. Current (from plus to minus) then travels through diode D1 (to protect against reverse voltage), into the battery positive terminal, through the battery (thus charging it), out the battery negative terminal, then through resistor R1 and

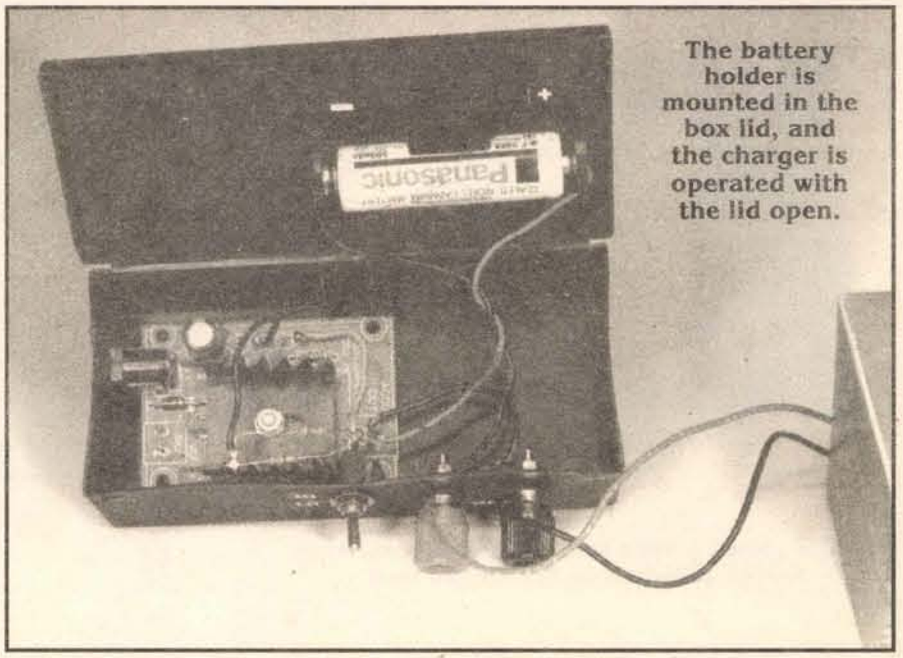


Mount the transistor together with the heatsink of the PCB, bend the leads as necessary. Take care that the metal back of the transistor touches the heatsink. Check that the leads of the transistor do not touch the heatsink.

Figure 4 - Heatsink installation.



The LED glows brightly as the battery is being charged.



The battery holder is mounted in the box lid, and the charger is operated with the lid open.

light-emitting diode LD1. In addition, with NPN power transistor T1 now positively base biased, current flows through the collector-emitter and resistor R2 to the circuit return.

The charging current is relatively constant as the battery charges, and is determined by a combination of the source voltage and the value of R2. The smaller the value of R2, the larger the constant current.

The total charging current flowing through the battery consists of the sum of the currents flowing through R1 and T1. This can easily be measured by inserting a milliammeter in series with the +OUT or -OUT terminals, as we'll detail later.

Electrolytic capacitor C1 merely stabilizes any ripple voltage from the input source.

Kit or Scratch-build?

While the Velleman kit uses "foreign" parts, there are USA equivalents for most parts, so you can build this charger from parts available from RadioShack or other sources. You can make your own printed circuit board, or assemble the parts on perforated board, since there is no critical parts-placement requirement.

However, building the charger from the Velleman kit has a number of advantages. An etched and drilled printed circuit board is included, with silk-screened part locations for the parts supplied. If you supply your own parts, the physical dimensions or connections may vary from the Velleman design. With the kit, all the proper parts are provided, and five different R2 resistors are supplied (some with very odd values) to allow you to build the unit for different charging rates.

Decisions, Decisions!

In any case, *before building* the battery charger, you'll need to decide exactly how you intend to use it. This involves the type of battery you will be charging, and whether you wish to make the modifications detailed later in this article.

For a given input voltage, the value of R2 determines the charging current. The desired charging current is based on the mAh capacity of the battery you will be charging. More on this later.

Assembly

If you build from scratch, the Parts List gives the USA equivalents of the "foreign" parts supplied with the kit. If you get the kit, the correct parts are supplied.

Figure 2 is the printed circuit layout if you decide to make your own, and Figure 3 is the parts lay-

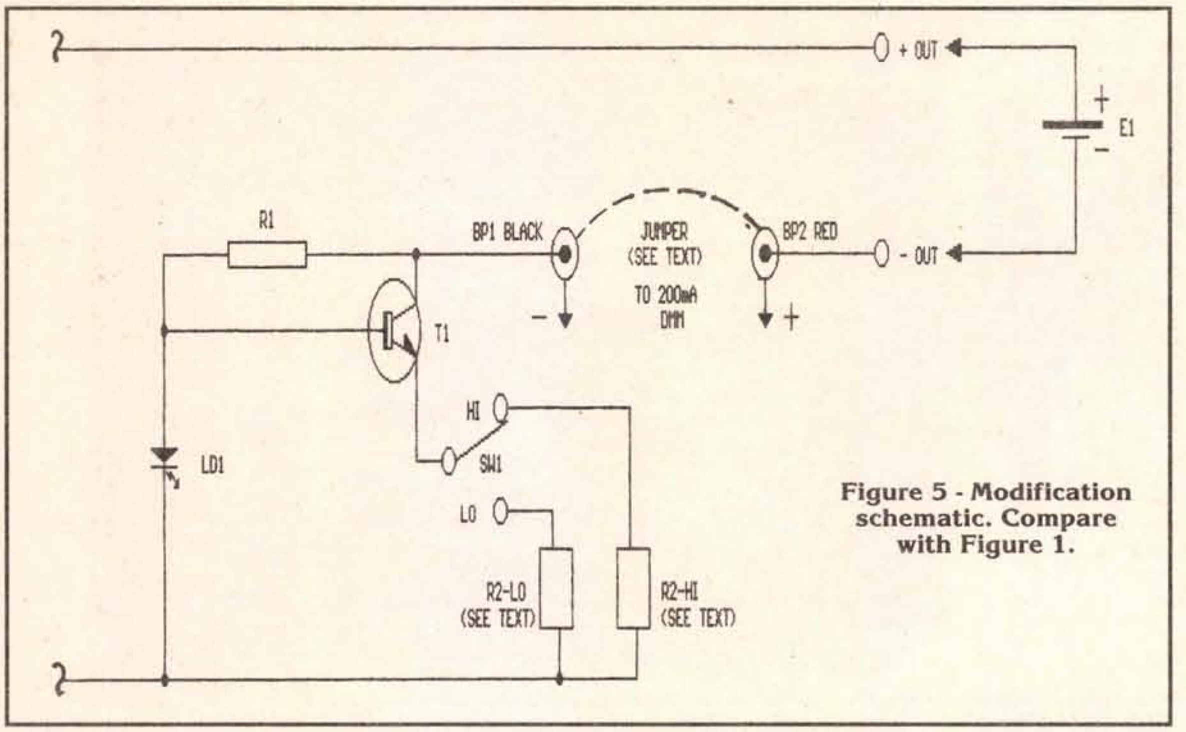


Figure 5 - Modification schematic. Compare with Figure 1.

RECHARGEABLE Ni-Cd BATTERIES

SIZE	VOLTS	mAh RANGE
AAA	1.25	180
AA	1.25	600-850
C	1.25	1400-2300
D	1.25	1400-4500

Table I: The capacities of Ni-Cd batteries vary with the size and manufacturer. These are RadioShack values.

RECHARGEABLE Ni-MH BATTERIES

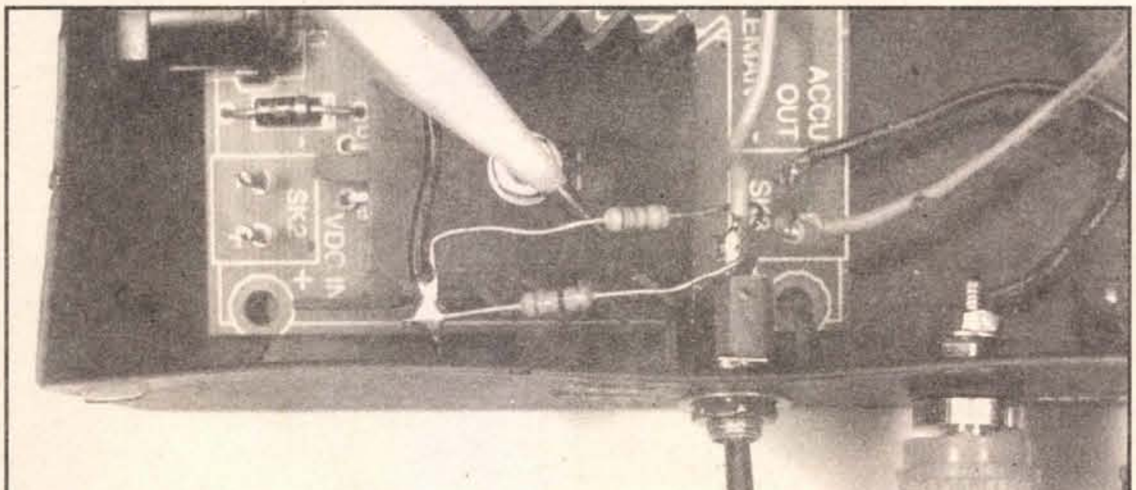
SIZE	VOLTS	mAh RANGE
AAA	1.2	550
AA	1.2	1500
C	1.2	2200
D	1.2	2200

Table II: The capacity of Ni-MH batteries available from RadioShack.

CHARGE CURRENT R2 VALUES

CHARGE CURRENT	R2 OHMS/WATTS
50 mA	47/.25
100 mA	18/.25
200 mA	6.8/.25
300 mA	3.9/.5
400 mA	2.7/.5

Table III: Once you decide the charging current you want, you'll need to select a value for R2. See the text.



The pencil points to the two resistors used for R2, selected by the toggle switch.

out using the printed circuit board and the parts supplied with the kit. Assembly is straightforward, although you should take proper care to properly orient polarity-sensitive D1, C1, LD1, and T1.

Note: If you plan to make the modifications described later in this article, do not install R2. Instead, use two bare wires to connect R2 externally for determining the proper value for your intended use. Details will follow.

A word about the heatsink. Unless you plan to charge at very high rates, like 400 mA, you may not have to use the heatsink. Even at 200 mA, the transistor does not get very hot. But, if you do use the heatsink, it goes on top of T1, and T1 must be placed with the metal side up, as shown in Figure 4.

Testing the Charger

Before packaging the charger or making any modifications, first test the assembled unit. Connect a 47-ohm .25-watt resistor to the leads that go to R2. Next, observing polarity, connect an AAA or AA Ni-Cd or Ni-MH battery to the OUT+ and OUT- battery terminals; a battery holder (see Parts List) makes this convenient.

Observing polarity, use 6.5 to 10 volts DC for the input voltage. This is not critical, because the circuit design provides a relatively constant current over a small range of input voltages.

The light-emitting diode, LD1, should light. LD1 cannot light unless current is flowing through the battery. However, this does not confirm that current is flowing

through transistor T1, and resistor R2.

To confirm current flow through R2, observe polarity and use a one ampere DC meter, or digital multimeter (DMM) set to 200 mA DC, placed in series with R2. You should read a current of roughly 50 mA. This is not the total charging current, since some current is also flowing through R1 and LD1.

Troubleshooting the Charger

If LD1 does not light, first verify that both the power supply and the battery are connected, and with the proper polarity. If these are confirmed, then make sure all the polarity-sensitive parts (D1, C1, T1, and LD1) are properly oriented.

Be aware that LD1 may light even if R2 is not installed, but that the battery charging current will be only the small current flowing through LD1. In a properly working unit, the majority of the charging current flows through transistor T1 and resistor R2.

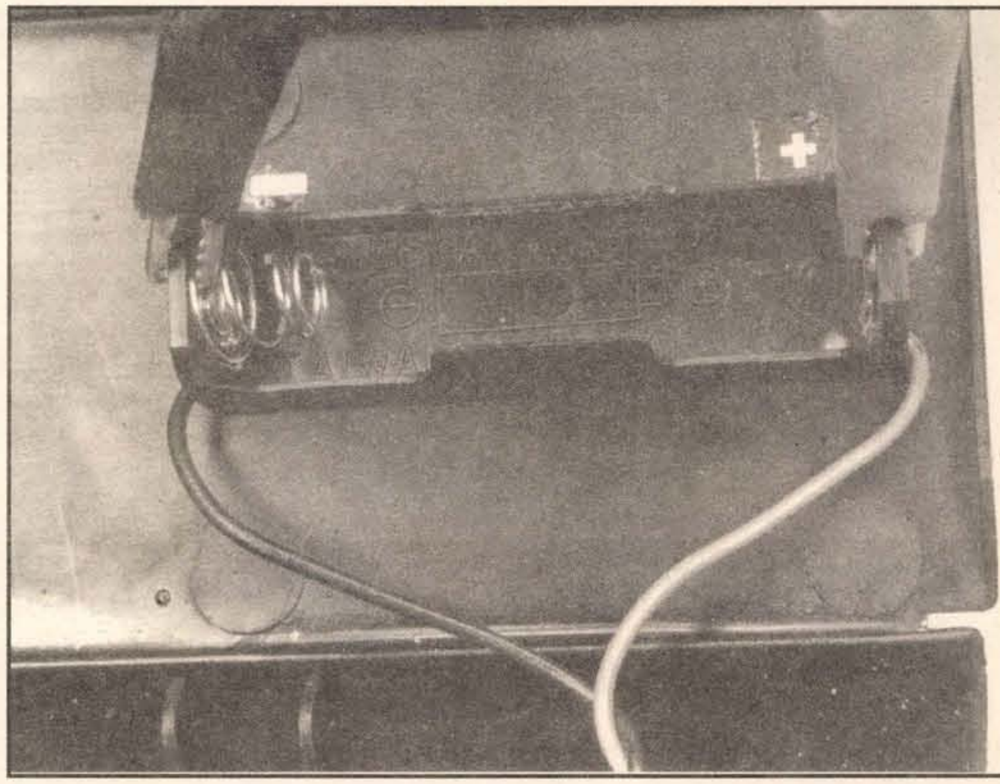
If current is not flowing through R2, then T1 is not conducting. Make certain that T1 is installed properly regarding the collector, base, and emitter leads. Of course, check all solder joints.

See Velleman's ad on Page 24!!

Modifications

To measure the total charging current (through R1 and T1), you can insert a meter in series with the battery. Also, you can provide a HI and LO charging current by using two different value resistors for R2, selected by a toggle switch.

Figure 5 shows these modifications to the original Figure 1 circuit. Just adding binding posts and a switch will allow you to accurately set HI (fast-charge) and LO (slow-charge) charging currents.

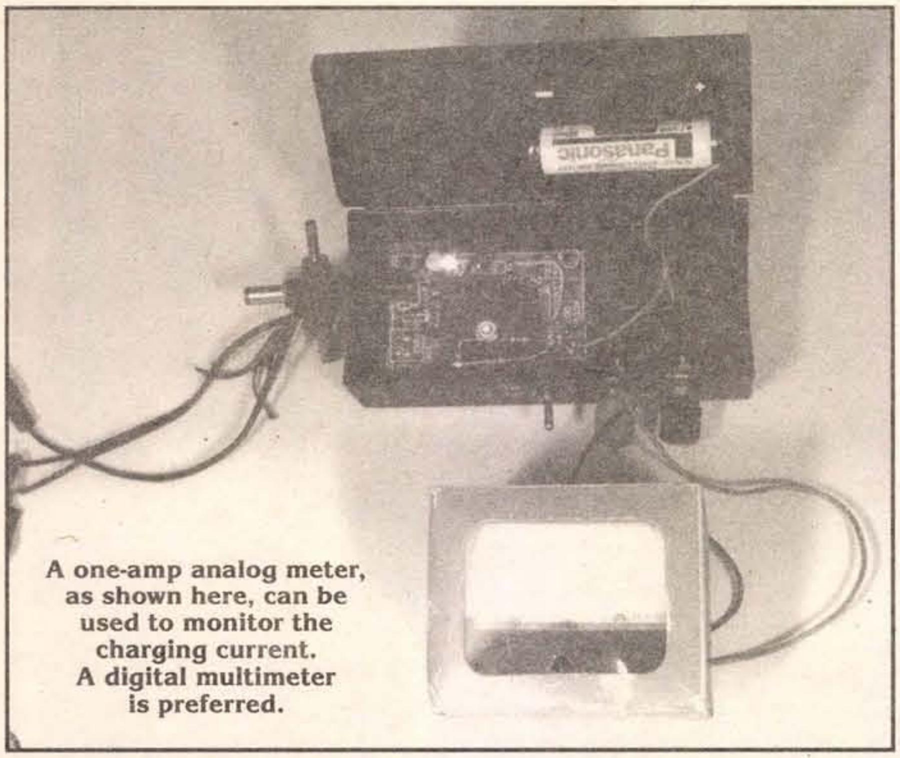


Alligator clips connected to the battery holder terminals may be used to charge an external battery of a different size.

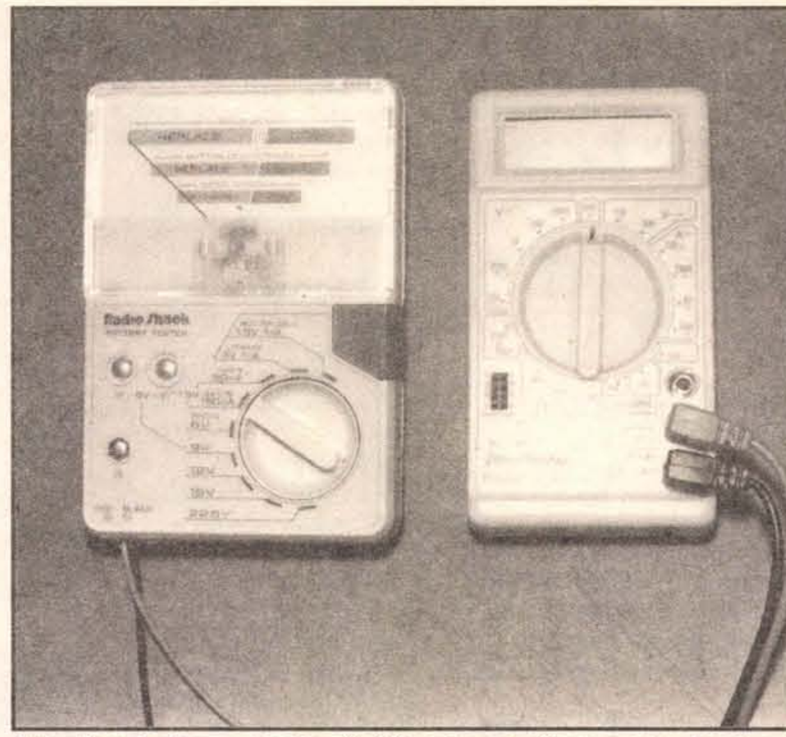
Binding posts BP1 and BP2 allow you to connect an external meter to measure the charging current you plan to use. I find a DMM most convenient and accurate. If you don't care to use a meter after selecting the proper HI and LO resistors for your application, just put a jumper between the binding posts to complete the circuit to R1 and T1.

The SW1 single-pole double-throw switch lets you select either a HI or LO charging resistor for R2. Any switch will do, but I find a small toggle switch the most convenient and easiest to install.

Before selecting the resistors to be used for R2-HI and R2-LO, you must decide what charging currents you want. This depends on the battery type and its mAh capacity. It is generally agreed you can slow charge a Ni-Cd or Ni-MH single cell battery at one-tenth its one-hour milliamp capacity. This is called 1/10C. For example, a 500 mAh battery can be safely slow-



A one-amp analog meter, as shown here, can be used to monitor the charging current. A digital multimeter is preferred.



A typical battery checker (left) puts a battery under load, and may show a salvageable battery as dead. A DMM (right) will show if there is ANY life left in the battery.

charged (LO) at 50 milliamperes.

To fast-charge, the accepted safe value for Ni-Cds is 2/10C. Note that Ni-MH batteries should only be slow-charged!

You can "breadboard" these changes before packaging the unit. Table III shows the values to try for R2 for different charging currents. (Each of these resistors is included in the Velleman kit.)

To more accurately determine the required value for the desired voltage input and charging current, use a meter between the binding posts, and substitute a low resistance value potentiometer for R2. Just power up the circuit and set the potentiometer for the desired current, then measure the potentiometer resistance and use a resistor for R2 close to the potentiometer resistance.

Packaging the Charger

I built the charger circuit, using the Velleman printed circuit board and parts, into my favorite small-project box, a Fuji slide box, as shown in the photos. Actually, all photos finishers have similar plastic boxes for packaging 35mm slides. The plastic is thin and easy to cut, and the lid acts as a cover.

For two basic reasons, it was decided to use the unit with the lid open. This allows you to see LD1 lighted, and provides easy access to the AA battery holder mounted (with double-sided tape) to the inside of the box lid. When the lid is closed, the holder fits inside perfectly. If you want to test other size batteries, just use clip leads to the battery holder terminals — observing polarity, of course.

Also, with the lid open, heat generated by the circuit does not get trapped, since it is "air conditioned."

I mounted the toggle switch and binding posts on the front of the box, and an entry hole for the power input on the side of the box. One end each of R2-HI and R2-LO mount to the switch terminals. Pretty neat!

Testing a Rechargeable Battery

The following applies to Ni-Cd batteries. I have not tried this with Ni-MH batteries, but I would expect them to respond the same way.

Before charging a rechargeable Ni-Cd battery, you really have to have an idea of what condition it is in. Some are in such bad shape they will not charge. I find the best way to determine this is with two simple tests: a voltage test and a resistance check.

First, do a voltage test, under no load, using a voltmeter; I prefer a DMM. Set the scale to the two volts DC scale, and touch the test leads to the battery terminals, observing polarity.

If you get even a small voltage reading (even as low as 0.2), the battery is probably chargeable. Note that a battery tester puts the battery under load, and will probably show a battery as "dead" that can be saved.

What about a battery that shows no voltage, even under no load? Use an ohmmeter (again, I prefer a DMM) to see if there is any internal resistance. If it reads close to 0.00, throw the battery away! It is so badly internally shorted it is not worth the trouble to try to save it.

However, if it reads 1.0 or more ohms, you might be able to save it by "zapping" it — hitting it with a blast of high DC voltage (+ to +, and - to -). While this can be done with a charged capacitor, you are safer and better off using a device designed for the purpose, such as "Build a Nickel-Cadmium Battery Zapper," in the February 1996 issue of *Nuts & Volts*.

If the battery "passes" the volt and ohms test, this charger will probably successfully charge it in four hours at the HI rate.

Using the Charger

Watching polarity for all items, connect the meter (or a jumper in place of the meter), place a battery in the holder (or use clip leads to an external holder), and supply power to the input jack or terminals.

LD1 should light, and the meter should show the charging current. Toggle the switch to HI or LO as desired, and see the charging current change on the meter. That's all there is to it. But remember that Ni-MH batteries should only be charged at the LO rate.

Do not expect the charging current to drop significantly as the battery charges. While charging, you can check the battery voltage at its terminals. It should read above 1.35 volts when the battery is charged and the charger is ON.

Charging single-cell Ni-Cd batteries at a HI or LO current, or charging single-cell Ni-MH batteries at a LO current, is simple with this charger. It maintains a relatively constant charging rate, uses an LED to verify that the battery is being charged, and will not overcharge the battery. **NV**

Parts List

The best source for these parts is www.radioshack.com, which you can access online, or toll-free at 1-800-442-7221 24 hours, and there is no minimum order. Some of the more common parts may be found at your local RadioShack store — but don't depend on it.

If you purchase the kit listed below, all required parts are supplied, although many have foreign part numbers. The parts listed below are the USA equivalents, with R/S indicating the www.radioshack.com order number.

C1 - 220uF 25VDC electrolytic capacitor (R/S 900-1629)
D1 - IN4001 silicon rectifier (R/S 900-2869)
LD1 - 3mm red light-emitting diode (R/S 900-6094)
R1 - 120-ohm 1/2-watt carbon-film resistor (R/S 900-0357)
R2 - Resistor. See Table III and text (Five resistors for R2 are supplied with the Velleman kit)
SK1 - Closed-circuit power jack (R/S 910-0731)
T1 - MJE-182 NPN silicon audio power amplifier transistor with TO-225AA case. (R/S 900-5286)
Heatsink - For TO-220 transistor (R/S 910-3255)

The complete Velleman K7302 kit, with all the parts shown above, plus a silkscreened etched and drilled printed circuit board and some terminal mounting posts, is available as R/S 990-0301 for $11.95.

Items for optional modifications:
SW1 - SPDT miniature toggle switch (R/S 900-7840)
BP1 - Black binding post (R/S 910-4242)
BP2 - Red binding post (R/S 910-4241)
Battery Holder - For single AA battery (R/S 910-0328)
Slide Box - Fuji or similar (any photo finisher)

Events CALENDAR

The Events Calendar is a free service for publicizing electronic events such as amateur radio hamfests, flea markets, etc. If your organization is sponsoring an event and would like a free listing, contact us at least 60 days in advance. Include your flyer, estimated attendance, name of the person to contact, and phone number.

Complimentary issues are available upon request for distribution to your attendees. A street address for UPS is required.

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Corona, CA 92879
Phone 909-371-8497
Fax 909-371-3052
E-mail events@nutsvolts.com

JANUARY 2001

January 6

TN - MORRISTOWN - Hamfest. Lakeway ARC, John Ellenburg KE4QIH, 423-581-5645. Email: ellenburg@icx.net
WI - WAUKESHA - Hamfest. Waukesha County Expo Center. 8am-2pm. West Allis RAC, Phil Gural W9NAW, 414-425-3649

January 10

PA - PHILADELPHIA - Ham & Auction Fest. Phil-Mont Mobile RC, Russ Stafford W3CH, 610-631-3401 (#4). Email: russ@hdj.com Web: http://www.phil-mont.org

January 12-13

FL - FT. MYERS - Hamfest. Shady Oaks Community Center, 3280 Marion St. Fri: 4pm-9pm, Sat: 9am-3pm. Talk-in: 146.880. Ft. Myers ARC, Earl Spencer K4FQU, 941-332-1503. Email: k4fqu@juno.com

January 13

NY - MARATHON - Hamfest. Skyline ARC, Andrew Slaugh KB2LUV, 607-753-0597. Email: kb2luv@arrl.net
OH - MIDDLETOWN - Digital Symposium. Dial RC, Hank Greeb N8XX, 513-385-8363 (after 6pm). Email: n8xx@arrl.net Web: http://w3.one.net/~rkuns/swohdigi.html
SC - GREENWOOD - Hamfest. Greenwood ARS, Frank Kolar WA9FWO, 864-229-5639
TX - SAN ANTONIO - Hamfest. Little Joe's Country Gold, 7405 Old Pearsall Rd. San Antonio RC, Royce Taylor KA5OHJ, 210-680-0432. Email: swapfest01@juno.com Web: http://community.webtv.net/k5ucq/SanAntonioRadioClub

January 14

IN - GOSHEN - Hamfest. Elkhart County Fairgrounds. 8am-2pm. Talk-in: 145.290. Michiana Valley Hamfest Assn., Denny Denniston KA9WNR, 219-291-0252 (7-10 PM EST).
OH - NELSONVILLE - Hamfest. Sunday Creek AR Federation, Russ Ellis N8MWK, 740-767-2226. Email: scarf@hocking.edu

January 20

LA - HAMMOND - Hamfest. SLU University Center, Columbus Dr. Ve testing. Talk-in: 147.000-. Southeast LA ARC, Bill Borstel KB5SKW, 225-695-6414. Email: wborstel@aol.com Web: http://www.selarc.org
MO - ST. JOSEPH - Hamfest. Ramada Inn, I-29 & Frederick Ave. FCC exams. Talk-in: 146.85 & 444.925. MO Valley & Ray-Clay ARCs, Carlene Makawski KA0IKS, 816-279-3406. Email: nem3238@ccp.com Web: http://www.kc.net/~oconnor
TN - GALLATIN - Hamfest. Gallatin Civic Center. Sumner County ARA, John Hermon WB5OOL, 615-451-0213. Email: hamfest@scara.net Web: http://www.scara.net

January 20-21

FL - SARASOTA - Hamfest. Sarasota ARA, Eddie Martin KI4ZJ, 941-378-8371. Email: ki4zj@hotmail.com

January 21

MI - HAZEL PARK - Hamfest. Hazel Park High School, 23400 Hughes St. 8am-2pm. Talk-in: 146.64-. Hazel Park ARC, Inc., Tom Krausnick WC9F, email: wc9f@arrl.org Web: http://www.qsl.net/w8hp
NY - NORTH BABYLON - NLI Section Convention. Babylon Town Hall Annex, Phelps Ln. 9am-4pm. VE testing. Great South Bay ARC, Phil Lewis N2MUN, 631-226-0698. Email: n2mun@optonline.net Web: http://www.arrlhudson.org/nli/hru2001.htm
NY - YONKERS - Flea Market. Lincoln High School, Kneeland Ave. 9am-3pm. VE Exams. Talk-in: 440.425 PL 156.7, 223.760 PL 67.0, 146.910, 443.350 PL 156.7. Metro 70cm Network, Otto Supliski WB2SLQ, 914-969-1053. Email: wb2slq@juno.com Web: http://www.metro70cmnetwork cmnetwork.com
VA - RICHMOND - VA Section Convention. The Showplace, 3000 Mechanicsville Turnpike (Rt. 360). 8:30am-3:30pm. Richmond Amateur Telecommunications Society, Pat Wilson K4OW, 804-932-9424. Email: k4ow@arrl.net Web: http://frostfest.rats.net

January 27

AL - GREENVILLE - Hamfest. Butler County Fairgrounds. 8am-3pm. Talk-in: 146.67, 441.225, 145.19. Butler County & Pike County RACES, Jerry McCullough KE4ERO, 334-382-7644. Email: ke4ero@alaweb.com
FL - ARCADIA - Hamfest. DeSoto ARC, Doug Christ KN4YT, Email: kn4yt@cyberstreet.com
MO - ST. CHARLES - Hamfest. St. Charles Exposition Hall, I-70 and Fifth St. 8am-2pm. Talk-in: 146.940-. St. Louis Repeater, Jim Glasscock W0FF, 314-647-9458. Email: jimfoxfox@aol.com Web: http://www.stlrepeater.org
NM - ALBUQUERQUE - Albuquerque Winter Tailgate Swapfest. Tom Ellis K5TEE, 505-291-8122. Email: k5tee@arrl.net
NY - LOCKPORT - Hamfest and Auction. Eagle's Hall, 6614 Lincoln Ave. Lockport ARA, Duane Robinson W2DLR, 716-791-4096. Robert Radmore N2PWP, 716-778-5058. Email: n2pwp@arrl.net Web: http://lara.hamgate.net

January 28

IL - CICERO - Hamfest. Sportsmans Park Race Track, 3301 S. Laramie Ave. 8am-1pm. VE testing. WCRA, 630-545-9950. Email: info@wheatonhamfest.org Web: http://www.wheatonhamfest.org
MD - ODENTON - Hamfest. Odenton Volunteer Fire Dept. Hall, 1425 Annapolis Rd. (Rt. 175). 8am-2pm. VE testing. Maryland Mobileers ARC, Tom Ostrosky W3NI, 410-766-9414. Email: ostrosky@erols.com Web: http://www.space4less.com/mmarc
OH - DOVER - Hamfest. Tusco ARC, Gary Green KB8WFN, 740-922-4454. Email: kb8wfn@tusco.net

FEBRUARY 2001

February 2-3

MS - JACKSON - Convention. Trade Mart Bldg., Fairgrounds. Fri: 5pm-8pm, Sat: 8am-4pm. VE testing. Talk-in: 146.76-. Jackson ARC, Ron Brown AB5WF, 601-956-1448. Email: ab5wf@arrl.net Web: http://www.jxnarc.org

February 3

KS - LA CYGNE - Hamfest. Mine Creek ARC, Ron Cowan KB0DTI, 913-757-4455. Email: kb0dti@arrl.net
MI - NEGAUNEE - Hamfest. Hiawatha ARA, Bill Beitel N8NRG, 906-226-2779. Email: n8nrg@portup.com Web: http://www.qsl.net/k8lod/
SC - NORTH CHARLESTON - Hamfest. Charleston ARS, Jenny Myers WA4NGV, 843-747-2324. Email: brycemyers@aol.com Web: http://www.qsl.net/wa4usn/index.html

February 3-4

FL - MIAMI - Southeastern Division Convention. Fair Expo Center, 10901 SW 24th St. (Coral Way). Dade Radio Club, Evelyn Gauzens W4WYR, 305-642-4139. Email: w4wyr@arrl.net Web: http://www.hamboree.org

February 4

OH - LORAIN - Hamfest. Gargus Hall, 1965 N. Ridge Rd. 8am-1pm. Talk-in: 143.700- and 444.800+. Northern OH ARS, John Schaaf K8JWS, 216-696-5709. Email: noars@qsl.net
TX - GEORGETOWN - Hamfest. Williamson County ARC, Mike Evans KD5AAD, Email: mlevans@mail.utexas.edu

February 5

AZ - PHOENIX - Auction. St. Clement of Rome Catholic Church Social Hall, 15800 Del Webb Blvd. Talk-in: 147.30+. West Valley ARC, Ron K6OP, 623-546-5710. Email: ronk6op@juno.com

February 9-10-11

FL - ORLANDO - Northern FL Section Convention. Central Florida Fairgrounds, 4603 W. Colonial Dr. Exams. Talk-in: 146.760 down 600, 145.110 down 600. Orlando ARC, Ken Christenson AF4ZI, 407-291-2465. Email: kd4jqr@juno.com Web: http://www.oarc.org/hamcat.html

February 10

MI - TRAVERSE CITY - Hamfest. Cherryland ARC, Joe Novak W8TVT, 231-947-8555
TX - CANYON - Hamfest. Cole Community Center, 300 16th St. Potter/Randall County ARES/RACES, Ben Pollard WS5R, 806-381-8810. Email: ws5r@arrl.net Web: http://www.qsl.net/nwtx-ares

February 10-11

TN - MEMPHIS - Convention. Shelby Co. Bldg., Mid-south Fairgrounds. Sat: 9am-5pm, Sun: 9am-2pm. Dixie Fest Committee, Ben Troughton KU4AW, 901-372-8031. Email: ku4aw@arrl.net Web: http://www.dixiefest.org

February 11

OH - MANSFIELD - Hamfest. InterCity ARC & MASER, Dean Wrasse KB8MG, 419-522-9893. Email: deanwrasse@yahoo.com Web: http://www.maser.org

February 16-17

OK - TULSA - Hamfest. Jones/Riverside Airport. Talk-in: 145.11 -600, 443.850 + 5MHz PL 88.5. Green Country Hamfest

COMPUTER SHOWS

AGI Shows, 317-299-8827
E-Mail: info@agishows.com
http://www.agishows.com

Blue Star Productions
612-788-1901
http://www.supercomputersale.com

Computers And You, 734-283-1754
www.a1-supercomputersales.com

Computer Central Shows
630-782-4625 Fax 630-834-2594
E-Mail: cc@gats.com
www.computercentralshows.com

Computer Country Expo
847-662-0811 Web: www.ccxpo.com

Five Star Productions
810-379-3333 E-Mail: jeff@fivestar
www.fivestarshows.com

Gibraltar Trade Center, Inc.
734-287-2000 Taylor, MI.
E-Mail: taylor@gibraltartrade.com
www.gibraltartrade.com

Gibraltar Trade Center, Inc.
810-465-6440 Mt. Clemens, MI.
E-Mail: mtclemens@gibraltartrade.com
www.gibraltartrade.com

KGP Productions
1-800-631-0062, 732-297-2526
E-Mail: kgp@mail.com

MarketPro, Inc., 201-825-2229
http://www.marketpro.com

MarketPro, Inc., 301-984-0880
E-Mail: md@marketpro.com
http://marketpro.com

ComputerShow
770-663-0983
E-Mail: narisaam@aol.com
Web: http://www.shownsale.com

Northern Computer Shows
978-744-8440
E-Mail: inquiries@ncshows.com
Web: ncshows.com

Peter Trapp Computer Shows
603-272-5008
Web: www.petertrapp.com

Committee, Merlin Griffin WB5OSM, 918-622-2277. Email: megriffin@ionet.net http://www.greencountryhamfest.org

February 17

CA - MONTEREY - Hamfest. Naval Postgraduate School ARC, Max Cornell K0MC, 831-883-0491. Email: cornell@redshift.com Web: http://k6ly.org/radiofest
MA - MARLBOROUGH - Hamfest. Algonquin ARC, Ann Weldon KA1PON, 508-481-4988. Email: annweldon@aol.com
OR - RICKREALL - Hamfair. Polk County Fairgrounds, 520 S. Pacific Hwy. W. 9am-3pm. Talk-in: 146.46. Salem Repeater Assn., & OR Coast Emergency Repeater, Dick Smith KK7OX, 541-997-4074. Email: kk7ox@presys.com Web: http://repeater.homepage.com

February 18

CO - BRIGHTON - Hamfest. Aurora Repeater Assn., Wayne Heinen N0POH, 303-699-6335. Email: n0poh@arrl.net Web: http://www.qsl.net/n0ara
MI - FARMINGTON HILLS - Hamfest. William Costick Activity Center, 28600 W. 11 Mile Rd. 8am-1:30pm. LARC, 734-261-5486. Email: swap@larc.mi.org Web: http://larc.mi.org
NY - WILLIAMSVILLE - Hamfest. Main Transit Fire Hall, 6777 Main St. Talk-in: 147.255. Lancaster ARC, Luke Calianno N2GDU, 716-634-4667 or 716-683-8880. Email: luke@towncountryflorist.com Web: http://hamgate1.sunyerie.edu/~larc

February 24

GA - DALTON - Hamfest. Dalton ARC, Harold Jones N4BD, email: n4bd@ocsonline.com
IN - LA PORTE - Hamfest. La Porte Civic Auditorium, 1001 Ridge St. 7am-1pm. LPARC, Neil Straub WZ9N, 219-324-7525. Email: nstraub@niia.net Web: www.geocities.com/k9jsi/
VT - MILTON - Hamfest & State Convention. Milton High School, Rt. 7. 8am-1pm. VE exams. Talk-in: 145.15. Radio Amateurs of Northern VT, Mitch Stern W1SJ, 802-879-6589. Email: w1sj@arrl.net Web: http://www.ranv.together.com

February 25

NY - HICKSVILLE - Hamfest. Levittown Hall, 201 Levittown Pkwy. Talk-in: 146.850 PL 136.5. Long Island Mobile ARC, Eddie Muro KC2AYC, 516-520-9311. Email: hamfest@limarc.org Web: http://www.limarc.org
OH - CINCINNATI - Hamfest. Hartwell Recreation Center, May St. off Caldwell Dr. 9am-4pm. ARPSC, 513-661-1805. Email: gldivision@juno.com Web: www.arpsc.com
OH - CUYAHOGA FALLS - Hamfest. Emidio's Party Center, 48 E. Bath Rd. 8am-2pm. Cuyahoga Falls ARC, Inc., Carl Hervol, 330-497-7047. Email: carlh@voyager.net
PA - CASTLE SHANNON - Hamfest. Wireless Assn. of South Hills, Steve Lane W3SRL, 412-341-1043. Email: washarc@yahoo.com Web: http://www.washarc.org/washfesty2k.htm
VA - ANNANDALE - Hamfest. Northern VA Community College. Vienna Wireless Society, Mike Toia K3MT, 703-757-7021. Email: k3mt@erols.com Web: http://winterfest.home.att.net

MARCH 2001

March 2-3

FL - NEW PORT RICHEY - Hamfest. Fred K. Marchman Technical Education Center, 7825 Campus Dr. 8am-5pm. Talk-in: 146.670. Gulf Coast ARC, Rick Brown KF4GXS, 727-863-1457. Email: richar@gte.net. Web: http://gcarc.cjb.net

March 3

AR - RUSSELLVILLE - Hamfest. Hughes Community Center, Knoxville & Parkway. 8am-4pm. Talk-in: 146.820. AR River Valley AR Foundation, Margaret Alexander KC5MCS, 501-968-7270. Email: ealexand@cswnet.com Web: http://www.cswnet/com/~arvarf/hamfest.htm
NJ - PARSIPPANY - Hamfest. PAL Bldg., 33 Baldwin Rd. VE session. Talk-in: 146.985-PL 131.8. Splitrock ARA, Peter Glenn KC2KI, 973-442-0772 or 888-511 SARA. Email: splitrock@worldnet.att.net Web: http://ham.hsix.com/sara

March 4

NY - LINDENHURST - Hamfest. Knights of Columbus Hall, 400 S. Broadway. 9am-2pm. VE exams. GSBARC & SCRC, Phil Lewis N2MUN, 631-226-0698. Email: info@gsbarc.org Web: http://www.gsbarc.org

March 10

AR - HARRISON - Hamfest. Harrison Junior High School Cafeteria, 515 S. Pine St. 8am-1pm. VE testing. North Arkansas ARS, Bill Rose N5VKF, 870-741-6968. Email: billrose@cswnet.com Web: http://www.qsl.net/naars
AZ - SCOTTSDALE - Hamfest. Scottsdale ARC, Roger Cahoon KB7ZWI, 480-948-1824 home, 602-725-7256 mobile. Email: rgcahoon@uswest.net
FL - ENGLEWOOD - Hamfest. Englewood ARS, JR House K9HUY, 941-475-3005
WA - PUYALLUP - Hamfest. Mike & Key ARC, Michael Dinkelman N7WA, 425-867-4797. Email: mwdink@eskimo.com

March 10-11

NC - CHARLOTTE - Hamfest & ComputerFair. Charlotte Merchandise Mart, 2500 E. Independence Blvd. The Mecklenburg ARS, Tom Hunt KA3VVJ, 704-948-7373 day & eves. until 9pm EST. Email: dealers@w4bfb.org Web: www.w4bfb.org/hamfest.html

Events CALENDAR

March 17

CT - POMFRET - Hamfest. Eastern Connecticut ARA, Paul Rollinson KE1LI, 860-928-2456. Email: kelli@arrl.net
FL - FT. WALTON BEACH - Hamfest. Playground ARC, Louis Carter KF4HRM, 850-243-4315. Email: parcfest@aol.com Web: http://www.bsc.net/playground/
FL - STUART - Hamfest. Martin County ARA, Romund Madson KS4KM, 561-337-1841

March 17-18

TX - MIDLAND - State Convention. Midland ARC, Pete Stull WB7AMP, 915-686-6755 or 915-362-6644. Email: W5QGG@arrl.net

March 18

IL - STERLING - Hamfest. Sterling-Rock Falls ARS, Lloyd Sherman KB9APW, 815-336-2434. Email: lsherman@essex1.com
OH - MAUMEE - Hamfest. Lucas County Recreation Center, 2901 Key St. 8am-2pm. Talk-in: 147.27+. TMRA, Paul Hanslik N8XDB, 419-385-5056. Web: www.tmrahamradio.org

March 24

CANADA - ONTARIO - BRAMPTON - Hamfest. Peel and Mississuaga ARCs, Michael Brickell VE3TKI, 905-826-5176. Email: ve3tki@rac.ca
MN - ST. PAUL - Hamfest. Concordia University. VE testing. Robbinsdale ARC, Harriet Johanson KB0UPH, 763-537-1722. Email: k0ltc@visi.com Web: http://www.visi.com/~k0ltc
WV - BECKLEY - Hamfest. Plateau ARA & Black Diamond ARC, James Martin KC8JSZ, 304-465-1428. Email: w373@inetone.net

March 25

IL - GRAYSLAKE - Hamfest. Lake County Fairgrounds. VE testing. Talk-in: 146.52 simplex. North Shore RC, Jacob Fishman KF9ZF, 847-291-4160. Email: kf9zf@arrl.net Web: http://www.ns9rc.org
NC - KINSTON - Hamfest. Down East Hamfest Assn., Doug Burt W4OFO, 252-524-5724. Email: jeanhd@icomnet.com
OH - MADISON - Hamfest. Lake County ARA, Roxanne N8BC, 440-209-8953 (9am to 9pm). Email: tbrown@ncweb.com Web: http://hamradio.org/lcara
PA - MONROEVILLE - Hamfest. Two Rivers ARC, Roxane Gaal WB3ROX, 412-823-6613. Email: gaal@pgh.net Web: http://www.qsl.net/w3oc/hamfest.htm

March 30-31

NE - NORFOLK - Convention. Northeast Community College Lifelong Learning Center, 801 E. Benjamin Ave. VE testing. Talk-in: 146.730-. Elkhorn Valley ARC, Sam Seikaly WA6BRE, 402-379-4073. Email: sseikaly@conpoint.com Web: http://www.qsl.net/evarc/

March 31

CT - WATERFORD - Auction. Waterford Senior Center, Rt. 85. Talk-in: 146.730-. RASON, Mark Noe KE1IU, 860-536-9633. Bruce Adams KA1ZMZ, 860-886-1837. Email: badams01@aol.com Web: http://www.rason.org
KY - ELIZABETHTOWN - Hamfest. Lincoln Trail ARC, Leon Priest N4TFK, 270-351-4721. Email: n4tfk@qsl.net Web: http://www.qsl.net/w4bej
TX - BRENHAM - Hamfest. Brenham ARC, Dan Lakenmacher N5UNU, 979-836-8739. Email: lindan@pointcom.net Web: http://www.alpha1.net/~barc

March 31-April 1

MD - TIMONIUM - Greater Baltimore Hamboree & Computerfest/MD State ARRL Convention. Timonium Fairgrounds, York Rd. Baltimore ARC, Sharon Dobson N3QQC, 410-HAM-FEST or 800-HAM-FEST. Email: k3duh@amsat.org Web: http://www.gbhc.org

APRIL 2001

April 6-7

WI - MILWAUKEE - AES Superfest 2001. Amateur Electronic Supply, Ray Grenier K9KHW, email: rayk9khw@aol.com

April 7

MO - LEBANON - Hamfest. Lebanon ARC, Chuck Sears AA0RK, 417-589-8122. Email: freedom1@advertisnet.com

April 8

NC - RALEIGH - Hamfest. Raleigh ARS, Chuck Littlewood K4HF, 919-872-6555. Email: k4hf@arrl.net Web: http://www.rars.org
WI - STOUGHTON - Hamfest. Mandt Community Center, Stoughton Junior Fairgrounds. Talk-in: 147.150. Madison Area Repeater Assn., Paul Toussaint N9VWH, 608-245-8890. Email: n9vwh@arrl.net Web: http://www.qsl.net/mara/

April 21

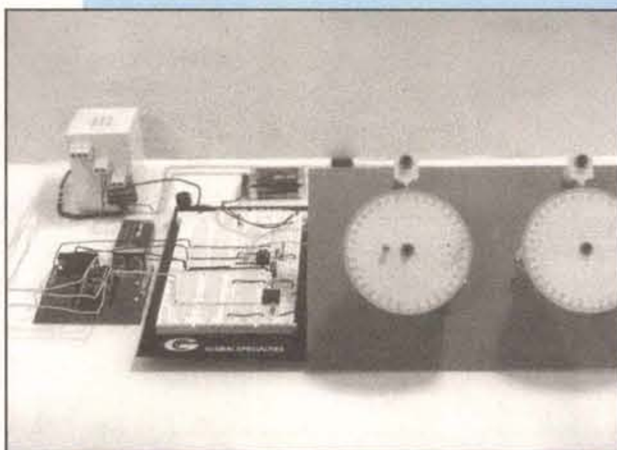
FL - TAMPA - Hamfest. Tampa ARC, Biff Craine K4LAW, 813-265-4812. Email: k4law@arrl.net Web: http://www.hamclub.org
VA - CHESAPEAKE - Hamfest. Chesapeake ARS, Richard Siff WA4BUE, email: melody@pilot.infi.net

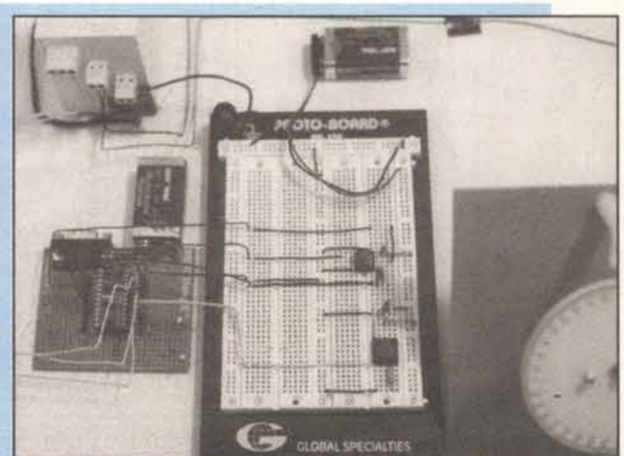
April 28

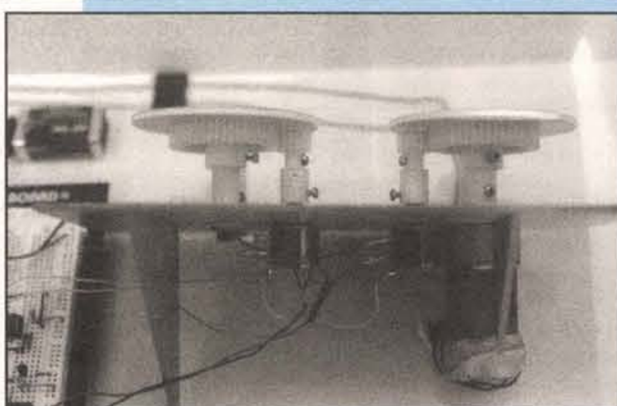
SC - WINDSOR - Hamfest. Salkehatchie ARS, Adam Hoffman AF4QZ, 803-245-4673. Email: af4qz@arrl.net Web: http://www.qsl.net/kf4cvo

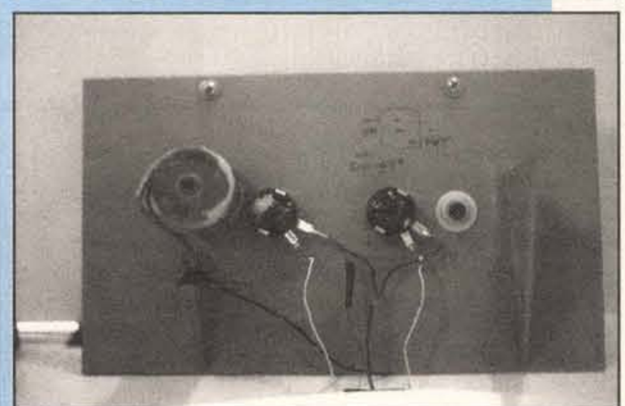
Closed Loop Feedback Control

by John M. Baxley









Introduction

This project shows how to set up a simple programmable feedback loop motor control system using components that are inexpensive compared to encoder/servo pairs. A set of guide plans and sample parts lists are provided — the goal being a good first project for the aspiring roboteer.

Background

Anyone who wants to learn robotics must eventually learn about closed (feedback) loop motor control. For some applications, just dictating the speed and time that a motor will be on allows a user to accurately position a mechanism. This type of control is called "open loop," which really means "no certainty that the motor moves the robot where you want it." Feedback control is the only way to reliably position a motor. This project shows how to use potentiometers as position sensors in a feedback control system. Excellent potentiometers are usually not expensive compared to encoders, and with some programming, can be used to good accuracy.

How it works

This project describes a "master-slave" set-up where a motor driven "slave" dial is programmed to rotate to a value matching (or related to) that of a "master" dial. It is in effect a programmable servo of sorts. This article is an extrapolation of the BS1 Application Note "#22 Interfacing to a 12-bit ADC" and the BS2 Application Note "Using Shiftin & Shiftout." This app note demonstrates one practical use of the data from an LTC1298 analog-to-digital converter. The lessons taught are

$N_{pot\ gear} := 13$ $\qquad n_{pot\ turns} := 3600 \cdot deg$

$N_{dial\ gear} := 48$ $\qquad divisions_{LTC1298} := 4096$

$$Angular\_resolution\_pot\_alone\_no\_gears := \frac{n_{pot\ turns}}{divisions_{LTC1298}}$$

$$Angular\_resolution\_pot\_alone\_no\_gears = 0.87891\,deg$$

$$Effective\_angular\_resolution\_using\_gears := \frac{\frac{N_{pot\ gear}}{N_{dial\ gear}} \cdot n_{pot\ turns}}{divisions_{LTC1298}}$$

$$Effective\_angular\_resolution\_using\_gears = 0.23804\,deg$$

Algorithm

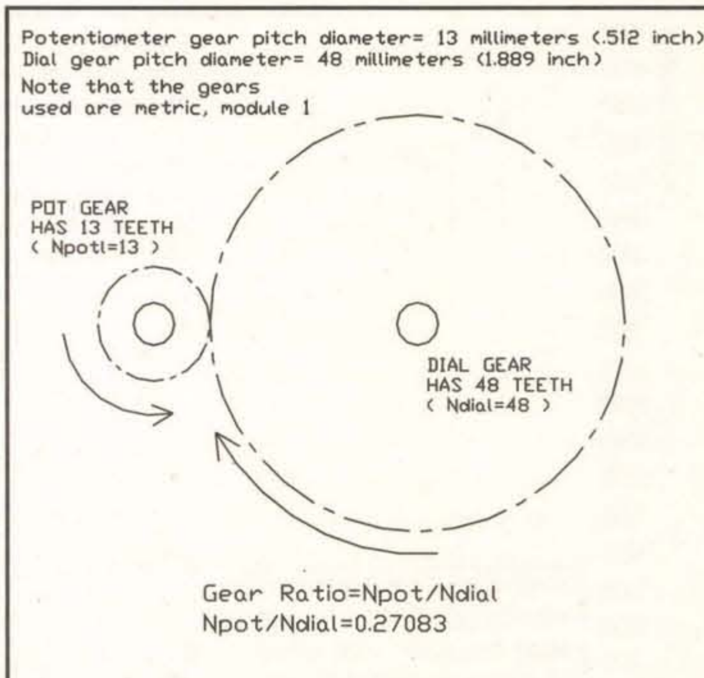
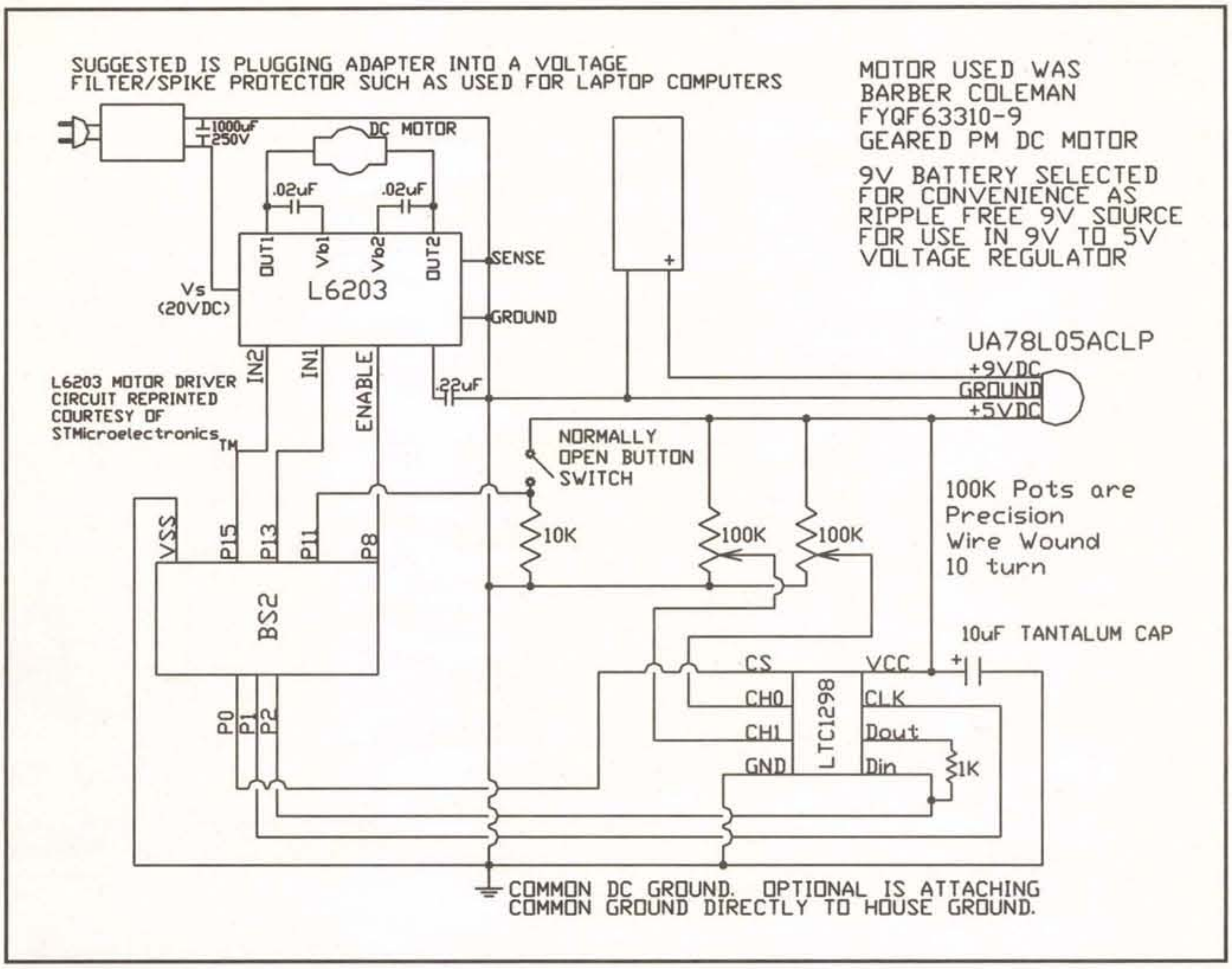


FIG #1
Potentiometer gear and dial gear in mesh. Gears are idealized and show only the PITCH CIRCLES where the gear teeth meet.



feedback loop programming, and a little gearing as related to accuracy of such a device. In addition, the project shows the use of the "pulsout" command, instead of "PWM" to provide better power and control of the motor circuit used in this project. The schematic shows the entire circuit, with its four "subsystems." Those being:

- Parallax, Inc., BS2: Computation and Data Manipulation
- LTC1298 ADC: Analog-to-Digital Conversion
- L6203: Motor Control
- UA78L05ACLP: 9VDC to 5VDC Voltage Regulation

What the schematic does not show is the manner in which the potentiometers are used. This project makes use of 100K ohm, 10 turn, high linearity potentiometers. These multi-turn precision pots yield small changes in resistance per one revolution (as opposed to a full 0-100K ohm range in 3/4 revolution for "regular" pots). This quality is vital here.

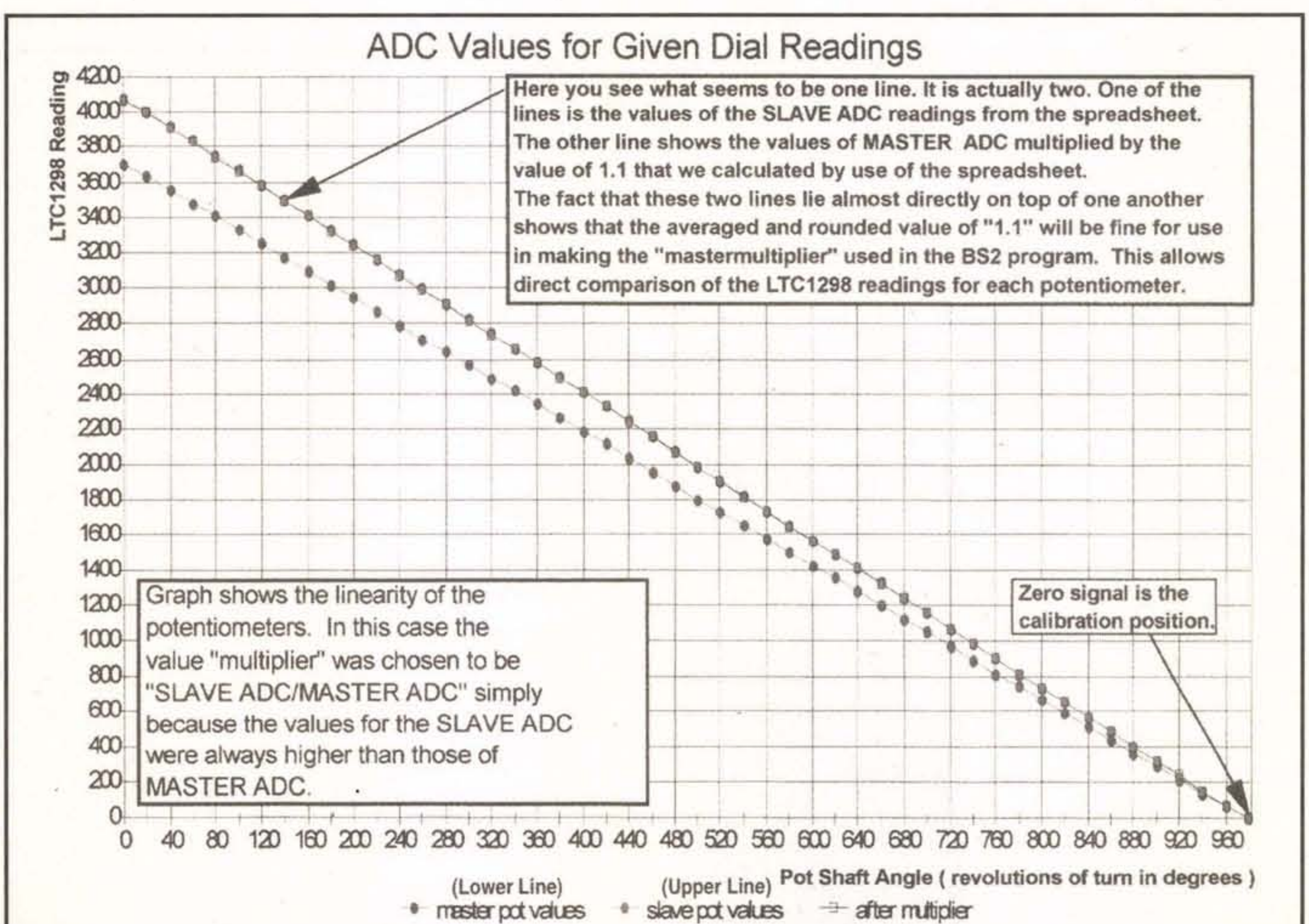
In order to further increase the device's accuracy, a simple gearing scheme is used. Take a look at Figure 1 for the concept. On the potentiometer shafts are attached 13-tooth gears. On the shaft of each indicator dial is attached a 48-tooth gear. The ratio between these two gears is 13/48 = .27083 Simply put, the equation says that for every full revolution of the 13-toothed gear potentiometer shaft, the 48-toothed gear dial shaft turns only .27083 revolutions, and vice versa.

The point being that the full 10 revolutions (360*10 = 3600 degrees = 10 revolutions) available from a pot shaft equate to 2.7083 total revolutions on a dial indicator shaft (3/48*360*10 = 975 degrees = 2.7083 revolutions). Conversely (and this is important), a small change in dial rotation corresponds to a proportionately larger change in potentiometer shaft rotation, 48/13 times larger to be exact (just the reciprocal of the 13/48 ratio mentioned before).

These larger pot shaft position changes yield equally large changes in the digital values from the LTC1298 ADC for just small changes in dial turn, the end effect being increased accuracy for the dial. Now, if the dial were connected directly to the potentiometer shaft, there would be an accuracy of 3600 degrees/4096 = .87891 degrees of pot shaft turn per division of the LTC1298 ADC signal.

Now that gearing is used, the 4096 readable divisions provided by the LTC1298 ADC are transgressed in not 10, but 2.7083 revolutions (975 degrees) of dial turn. This makes the effective resolution of the dial 975 degrees/4096 = .23803 degrees. This is a theoretical value only! In practice, the resolution is usually about three times this for this simple set-up. (The manual's BS1 app note "#22 Interfacing to a 12-bit ADC" gives a full explanation of these 4096 divisions of the LTC1298.)

Check out the sidebar where all of the information just presented is in one algorithm.



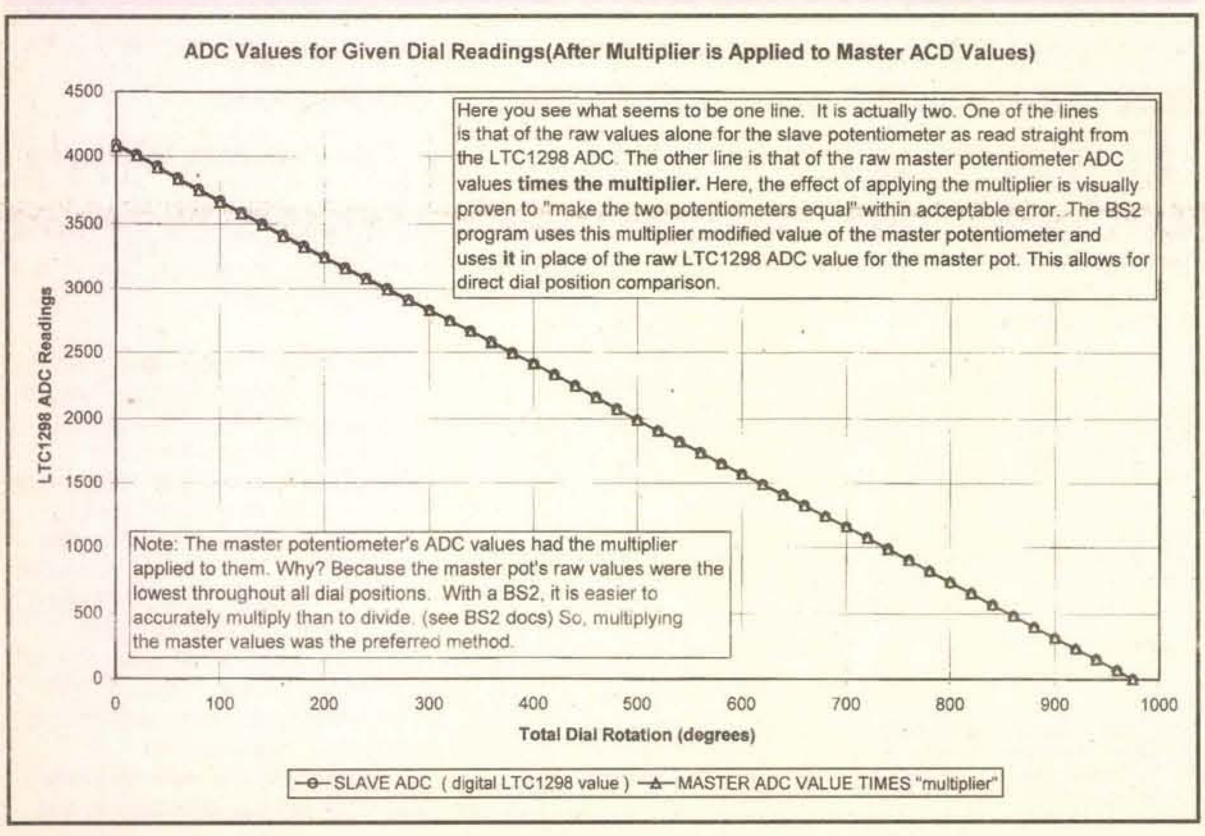
Calibration and Programming

At the core of this program is an LTC1298 ADC (analog-to-digital converter) operating in single ended, two channel mode. The BS2 program uses the "shiftout" command to configure the LTC1298 ADC, telling it the mode it will operate in, and what channel will be read at the time. The LTC1298 ADC then reads the 0-5VDC analog signal off of that channel's potentiometer wiper and compares this signal's strength to that of the 5VDC reference voltage (the LTC1298 5VDC source voltage).

WHEEL ANGLE (ON DIAL)	WHEEL ANGLE (ACTUAL)	MASTER ADC (digital LTC1298 value)	SLAVE ADC (digital LTC1298 value)	SLAVE ADC/MASTER ADC "multiplier"	MASTER ADC VALUE TIMES "multiplier"
0	0	3699	4088	1.105	4069
20	20	3636	4009	1.103	4000
40	40	3558	3924	1.103	3914
60	60	3482	3840	1.103	3830
80	80	3404	3756	1.103	3744
100	100	3326	3667	1.103	3659
120	120	3250	3583	1.102	3575
140	140	3173	3500	1.103	3490
160	160	3095	3416	1.104	3405
180	180	3018	3332	1.104	3320
200	200	2944	3248	1.103	3238
220	220	2868	3165	1.104	3155
240	240	2793	3083	1.104	3072
260	260	2716	3001	1.105	2988
280	280	2640	2915	1.104	2904
300	300	2567	2831	1.103	2824
320	320	2493	2747	1.102	2742
340	340	2418	2666	1.103	2660
0	360	2341	2582	1.103	2575
20	380	2264	2495	1.102	2490
40	400	2192	2412	1.100	2411
60	420	2116	2330	1.101	2328
80	440	2039	2246	1.102	2243
100	460	1961	2161	1.102	2157
120	480	1882	2074	1.102	2070
140	500	1806	1989	1.101	1987
160	520	1733	1908	1.101	1906
180	540	1654	1825	1.103	1819
200	560	1577	1740	1.103	1735
220	580	1501	1653	1.101	1651
240	600	1427	1572	1.102	1570
260	620	1352	1491	1.103	1487
280	640	1275	1408	1.104	1403
300	660	1198	1324	1.105	1318
320	680	1124	1236	1.100	1236
340	700	1049	1154	1.100	1154
0	720	975	1072	1.099	1073
20	740	897	989	1.103	987
40	760	821	904	1.101	903
60	780	747	819	1.096	822
80	800	671	734	1.094	738
100	820	595	652	1.096	655
120	840	516	567	1.099	568
140	860	438	483	1.103	482
160	880	361	397	1.100	397
180	900	287	314	1.094	316
200	920	212	229	1.080	233
220	940	135	150	1.111	149
240	960	60	64	1.067	66
257	975	0	0	0.000	0

ADC Values for Given Dial Readings

1.101<—— Statistical Average of Multiplier
1.1<——"multiplier" that is actually chosen by rounding to one decimal place
This value of 1.1 is multiplied by 10 to give us the value for the "mastermultiplier" used in the BS2 program.



Once the signal's strength is read, the 12-bit LTC1298 ADC turns this analog signal strength into a number from 0 to 4095 ($2^{12} = 4096$), and this value is handed off to the BS2 by use of the "shiftin" command.

The BS2 program stores each channel's raw analog-to-digital value (designated "AD" in the program), manipulates each channel's raw AD values into something directly comparable, compares these manipulated values, and then commands motor movements in accordance with the results of each comparison.

What this boils down to is that the lowest possible "raw" (not manipulated) value delivered to the BS2 by the LTC1298 is 0, and the highest is 4095, with the resolution being "1 division." All the LTC1298 can do is report the digital values — 0 to 4095 — of the analog signal coming from a potentiometer wiper. All the BS2 program can do is compare to see if the values for both pots are a "match" within specified limits.

It is your job to make sure that the potentiometer values "make sense," and are usable by the program. So how does one do this?

Since the 0 to 4095 digital value is indicative of the potentiometer shaft's rotational position, it's also indicative of the dial shaft rotational position because they are connected by the gears. In a perfect world, both potentiometers would yield equal readings for equal rotational positions, but potentiometers are analog devices and no two are ever exactly alike.

Thus, the raw potentiometer values of any two of the same make of pot will always be different for the same number of turns, and thus are not really usable for direct comparison of dial positions. There is a way around this though.

These differences can be measured, accounted for by calculating a special "master-multiplier" number, and then using it in the BS2 program. A spreadsheet is helpful for this. Take a look at the table "ADC Values for Given Dial Readings" and the graph of the same.

The table and chart show the LTC1298 digital value for each pot when they are turned to the same positions. Notice that the graphs of these measurements make two straight lines, hence the term "high linearity potentiometer."

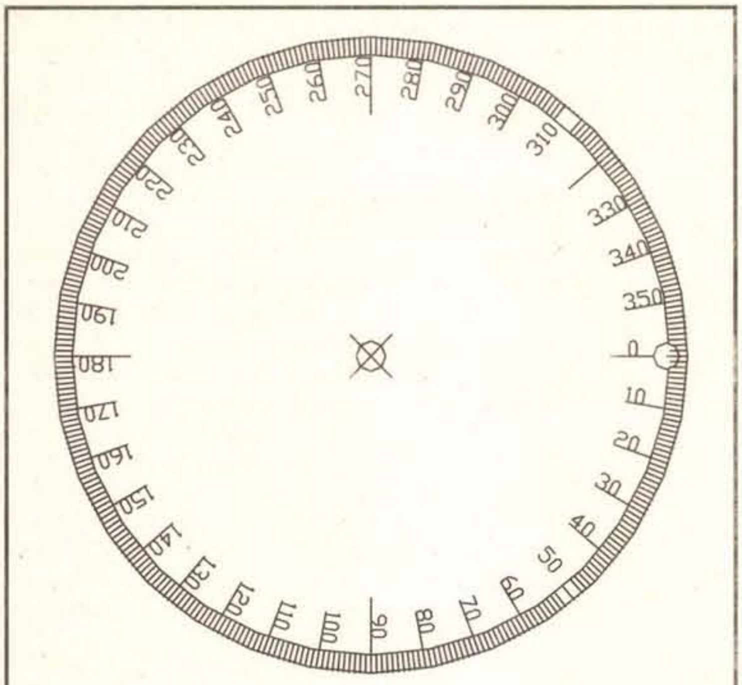
These two lines don't have the same slope, but they do have a common point where both of the potentiometers are at zero resistance (zero signal, zero LTC1298 reading). There is a mathematical property of lines that states that if two lines meet at a point, you can multiply all values of one of the lines by some special "multiplier" value to make both lines collinear. That is, make them "lie on top of one another," becoming equal. Why do this?

If we make both pots have the same LTC1298 value for 20, 40, 60 degrees of dial turn and so on, we can directly compare where they are oriented. Same value for each pot for equal number of turns. Same value on the dials. You have a "servo."

So, how do you calculate the "multiplier?" There are two steps:

- Finding of LTC1298 values for a given dial turn angle for each pot.
- Setting up dial calibration.

In the spreadsheet table, you will see the LTC1298 readings of each pot for 0 to 975 degrees of dial turn measured in 20-degree increments. These values were found by using the BS2 program itself as an LTC1298 output value reader. (Look at the program for clarification on this.) In the column designated



DIAL TEMPLATE

SLAVE ADC/MASTER ADC
"multiplier"

you will see that if you divide the slave pot reading by the master pot reading, you get close, but not equal values at each 20-degree increment of dial turn. They will all be pretty close because the pots have the crucial feature of high linearity.

Once all of these

SLAVE ADC/MASTER ADC
"multiplier"

values have been calculated, use the spreadsheet's simple average function to get the average of all of these single "multiplier" values.

In this project spreadsheet, this value is seen at the block labeled

1.101 <--Statistical Average of Multiplier

Once this number is found, it must be rounded off to one decimal place. Why? The BS2 can't do floating point math. No decimals allowed. We will get rid of all but one decimal place here, and then later make this one decimal number an integer for use in the BS2 program. No problem. Notice that just below the Statistical Average Multiplier is a block where the number was rounded off to one decimal place.

1.1 <--"multiplier" that is actually chosen by rounding to one decimal place

This value of 1.1 is multiplied by 10 to give us the value for the "mastermultiplier" used in the BS2 program.

This "1.1" is then used as the "multiplier." When the values of the master potentiometer are multiplied by this averaged and rounded off multiplier number, they end up being quite close to the values (but not exactly) of the slave pot. Look at the spreadsheet values under the block

MASTER ADC
VALUE TIMES
"multiplier"

and the graph "ADC Values for Given Dial Readings" show what happens to the lines of the potentiometer values when the multiplier is applied. The graph shows that where there were two distinct lines, there now seems to be only one. That is because applying the averaged and rounded multiplier makes the two pot's values satisfactorily "equal" at any rotational position, making the two pots "the same," and directly comparable for use in the BS2 program as soon as the "multiplier" is made into the integer "mastermultiplier."

To make the "multiplier" an integer usable by the BS2, simply multiply it by 10. This makes the one place decimal "1.1" equal the integer "11". As for any comparison number that would be multiplied by one (left alone really) we multiply it by 10 also. This way, the BS2 program compares the LTC1298 values according to the same ratio as that found in the spreadsheet program.

Take a look at the BS2 program lines

```
mastermultiplier=11
slavemultiplier=10
tweak=250
```

The value "`mastermultiplier=11`" is derived from the spreadsheet process. The "`slavemultiplier=10`" is, just like in the spreadsheet, the reading directly read from the slave pot, but instead of being "multiplied by 1.0," it is now multiplied by "10." Having found this "11" for mastermultiplier, and using just "10" for our slavemultiplier, there's one more small detail to look at. Notice the value "tweak." This value is simply a tuning value that is changed by trial and error.

After doing the main calibration (by simply turning both pots to the

```
'PULSOUTSERVO.BS2
'This program uses analog to digital conversion for the making of a practical programmable servo.
'The program takes the multiplier that was derived from the spreadsheet and utilizes it to enable direct dial position
'comparison of the raw LTC1298 ADC values.

DIO_n                    con   2             ' Data I/O pin _number_.
CLK                      con   1             ' Clock to ADC; out on rising, in on falling edge.
CS                       con   0             ' Chip select; 0 = active
config                   var   nib           ' Configuration bits for ADC.

startB                   var   config.bit0   ' Start bit for comm with ADC.
sglDif                   var   config.bit1   ' Single-ended(1 pot)or differential mode.
oddSign                  var   config.bit2   ' Channel selection.
msbf                     var   config.bit3   ' Output 0s after data xfer complete.

AD                       var   word          ' Variable to hold 12-bit AD result. Each channel's analog
                                             ' potentiometer signal is immediately turned into this digital
                                             ' number in the LTC1298 ADC and then sent to the BS2 where it is
                                             ' manipulated.  After manipulation, the AD value is turned into
                                             ' either the 12 bit word "slavePOTval" or "masterPOTval" depending
                                             ' which channel is being read.

slavePOTval              var   word          'Value that 12 bit word "AD" is manipulated into. These are the
masterPOTval             var   word          'actual values that are compared, not the raw word value "AD"

mastermultiplier         var   nib           'The numbers used in manipulation of the "AD" value. The value of
slavemultiplier          var   nib           '"mastermultiplier" was found in the spreadsheet analysis,and has a
tweak                    var   byte          'value of 11. The value "slavemultiplier" is simply 10. The value
                                             '"tweak" is found by trial and error to tune in both DIALS to zero.

pinCCW                   var   byte          'Just the BS2 pins which turn on/off the electronics which make the
pinCLOCKWISE             var   byte          'motor turn either ClockWise or CounterClockWise

PULSOUT_TIME_FULLAHEAD   var   word          'Dictates the duration of time, in 2E-6 second intervals, that the
PULSOUT_TIME_MEDIUM      var   word          '"PULSOUT" command will turn the motor on. These three PULSOUT
PULSOUT_TIME_SLOWDOWN    var   word          'variable determine the amount of time the motor pulses will be at
                                             'full ahead (two manipulated pot values not even close),
                                             'medium (getting closer), and when slowing down (the values of
                                             '"slavePOTval" and "masterPOTval" getting close to matching).
                                             'These are used to step down motor speed and prevent a fast turning-
                                             'dial from overshooting the mark once the values "slavePOTval" and
                                             '"masterPOTval" match within limits specified in the IF statements.

TICKS_FULLAHEAD          var   word          'The "ticks" are just comparison numbers that are used to compare the
TICKS_MEDIUM             var   word          'values of "slavePOTval" and "masterPOTval". The comparison determines
TICKS_SLOWDOWN           var   word          'when the motor slows down before stopping.

btnWk                    var   bit           'A bit which is used to test the on or off state of the start button.

PULSOUT_TIME_FULLAHEAD=1500                  'The "PULSOUT" command dictates the length of power pulses going to
PULSOUT_TIME_MEDIUM=700                      'the motor, in 2E-6 second intervals. For example: 1500*(2E-6)=.003
PULSOUT_TIME_SLOWDOWN=300                    'seconds of power pulse time. These pulse times are repeated over and
                                             'over in the program, the resulting stream of pulse times dictating
                                             'power to the motor at any given time.

TICKS_FULLAHEAD=1000                         'Example: When the absolute value difference between "masterPOTval"
TICKS_MEDIUM=500                             'and "slavePOTval" is 1000 units (analog to digital signal conversion)
TICKS_SLOWDOWN=30                            'the motor is instructed in IF statements to run at full ahead speed.

pinCCW=15                                    'Power on pin 15 makes motor turn CounterClockWise, on 13 ClockWise
pinCLOCKWISE=13

mastermultiplier=11                          'Again, the values for "mastermultiplier" and "slavemultiplier" were
slavemultiplier=10                           'calculated in the spreadsheet program, and then both multiplied
tweak=250                                    'by 10 to make the 1.1 calculated in the spreadsheet the 11 you see
                                             'in the program line "mastermultiplier=11" (1.1*10=11 easy!)
```

zero signal position and setting the dials at zero), one will find that there are still discrepancies between the master dial reading and the slave dial reading. Small changes in the "tweak" value will help one to get rid of these differences in dial value for any given position, but you will almost never get complete dial match across all 2.7083 revolutions of dial turn.

What you can get is an accurate range left or right from a certain master dial position. A little experimentation will reveal the best positioning of the dials and pot shafts so as to get accurate results ±90 degrees from a master dial position. Choosing this master dial position as your new "zero" point completes the "calibration."

With the calculated program values and the "calibration" done, the user will be able to get about 180 degrees of accurate turn positioning, which is comparable to the range of many servos. It is critically important to note that this gearing set-up is simplistic in the extreme. The main goal is to show the use of gearing to increase accuracy at the cost of available dial turn. One can get very good accuracy through use of a gear train that, for example, turned the pot 10 full turns in 1/2 revolution of dial turn (a 20:1 ratio, or 1:20 ... your pick).

The overall program logic stresses the BS2 syntax of "IF-THEN and "GOTO" statements. After the button is pressed, the hardware is initialized. Then an endless loop is started at the subroutine "again:" The analog values of each pot are read and turned into raw digital values. These raw values are manipulated into the variables "masterPOTval" and "slavePOTval" (which can be directly compared due to your choice of "mastermultiplier") Using "IF" statements, along with an "AND" statements, the values of "masterPOTval" and "slavePOTval" are compared. Two things are checked:

- which value is larger (dictates direction motor will turn for corrective action)
- how large a difference there is between the two comparison values (dictates how fast the motor will turn at the time)

The endless loop constantly compares values and the two conditions are used to dictate the corrective action the motor should take to bring the master and slave dial to matched positions.

The desired dial positions are often equal, as seen in this project, but one could always change the value of "mastermultiplier" and "slavemultiplier" to make the slave dial go to a position related, but not equal to, the master dial's value. One could also put formulas in the "IF-THEN" statements that would make the motor turn its dial in proportion to the master potentiometer's signal.

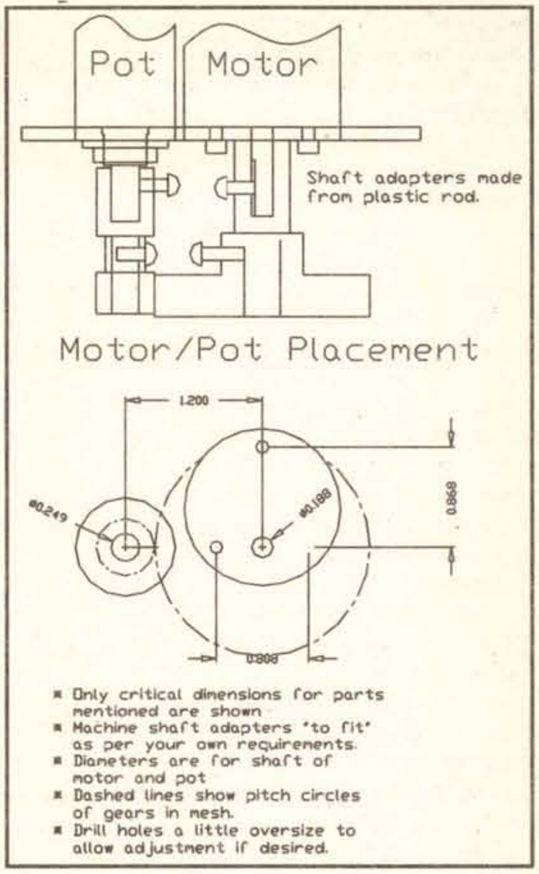
```
                                             'The line "slavemultiplier=10" came simply from the fact that 1*10=10
                                             'All values had to be multiplied by 10 before comparisons could be
                                             'made. Multiplying by 10 is essentially leaving the number unchanged.
                                             'The value "tweak" was found by trial and error till dials both lined
                                             'up from my chosen DIAL zero once I found the "sweet spot" where
                                             'the BEST linearity BETWEEN the potentiometers was located.

'*************BEGIN MAIN PROGRAM*************

btnWk=0

Buttonloop:
BUTTON 11,1,255,0,btnWk,1,startme                'Keep checking if button is pressed. If button is pressed, go to
goto Buttonloop                                  '"startme:" program line.

startme:                                         'Initialize hardware: Bring pin 8 high, enabling the motor circuit.
HIGH 8

high CS                                          'Make sure LTC1298 is initialized (the off state) by setting pin high
high DIO_n                                       'Set the data input/output pin high, ready for first start bit.

again:

 FOR oddSign = 0 to 1                            'Here the analog, 0-5VDC, potentiometer signal from each LTC1298
                                                 'channel is read and turned into the digital value "AD".
        config = config | %1011                  'This "AD" value is then manipulated into the values "masterPOTval"
        low CS                                   'and "slavePOTval", which are used to directly compare dial
        shiftout DIO_n,CLK,lsbfirst,[config\4]   'orientations.
        shiftin DIO_n,CLK,msbpost,[AD\12]
        high CS

        IF oddSign=0 THEN isZero
        masterPOTval=AD*mastermultiplier+tweak   'The value for "tweak" is something you will have to experiment with.
                                                 'Once the proper value for "tweak" has been found, the slave dial's
                                                 'value will follow the master dial's value very closely over about
                                                 '270 degrees of travel from your chosen DIAL zero.

        goto pickup1

        :isZero
        slavePOTval=AD*slavemultiplier

pickup1:

NEXT

'"Unrem" the debug comments and then rem out or delete all of the IF statements ( BUT NOT THE "goto again" )
'in order to use this program as an LTC1298 value reader. (See program "PotTest1.BS2") This will let you perform the linearity test for each
'potentiometer and get the values needed for your spreadsheet analysis. Once this is done you can calulate your
'particular value for "mastermultiplier".

'debug "masterPOTval ",DEC masterPOTval," *** slavePOTval ",DEC slavePOTval,cr '<—SHOWS ACTUAL LTC VALUE

'*****REM OUT OR REMOVE ALL IF STATEMENTS BETWEEN THESE ASTEREISK LINES TO PERFORM POTENTIOMETER LINEARITY TEST *******
'**********************************************************************************************************************
'Each IF statement first sees which value is greater ( this determines which direction the motor will turn )
'As soon as one of the IF statements check out as "TRUE" for both of its "AND" arguments, the program jumps to
'the appropriate motor control command line.

IF (masterPOTval < slavePOTval) AND ABS(masterPOTval-slavePOTval)>TICKS_FULLAHEAD THEN turnonewayfast
IF (masterPOTval > slavePOTval) AND ABS(masterPOTval-slavePOTval)>TICKS_FULLAHEAD THEN turnOTHERwayfast

IF (masterPOTval < slavePOTval) AND ABS(masterPOTval-slavePOTval)>TICKS_MEDIUM THEN turnonewaymedium
IF (masterPOTval > slavePOTval) AND ABS(masterPOTval-slavePOTval)>TICKS_MEDIUM THEN turnOTHERwaymedium

IF (masterPOTval < slavePOTval) AND ABS(masterPOTval-slavePOTval)>TICKS_SLOWDOWN THEN turnonewayslower
IF (masterPOTval > slavePOTval) AND ABS(masterPOTval-slavePOTval)>TICKS_SLOWDOWN THEN turnOTHERwayslower

'If none of the above "IF" statements chack out as "TRUE" then the values of "masterPOTval" and "slavePOTval" match to
'within the number of units designated in the variable "TICKS_SLOWDOWN" ( in this program, 30 units ) and no motion results.

'**********************************************************************************************************************
'*****REM OUT OR REMOVE ALL IF STATEMENTS BETWEEN THESE ASTEREISK LINES TO PERFORM POTENTIOMETER LINEARITY TEST ********

goto again'VERY IMPORTANT THIS GOTO IS...IT KEEPS PROGRAM FROM EVER GOING TO STATEMENTS BELOW AFTER CHECKING ALL CONDI-
TIONS.
                '(Used when the motor needs no moving, and when all the "IF" statements are rem'd out for pot's linearity test.)

'The IF statements above direct the program to a particular motor control command line where the motor is given the
'appropriate power pulse duration and direction. ("PULSOUT" command gives better motor power for this project setup.)

                turnonewayfast:                                    'CCW ROTATION
                PULSOUT pinCCW, PULSOUT_TIME_FULLAHEAD
                goto again

                turnOTHERwayfast:                                  'CW ROTATION
                PULSOUT pinCLOCKWISE, PULSOUT_TIME_FULLAHEAD
                goto again

                turnonewaymedium:                                  'CCW ROTATION
                PULSOUT pinCCW, PULSOUT_TIME_MEDIUM
                goto again

                turnOTHERwaymedium:                                'CW ROTATION
                PULSOUT pinCLOCKWISE, PULSOUT_TIME_MEDIUM
                goto again

                turnonewayslower:                                  'CCW ROTATION
                PULSOUT pinCCW, PULSOUT_TIME_SLOWDOWN
                goto again

                turnOTHERwayslower:                                'CW ROTATION
                PULSOUT pinCLOCKWISE, PULSOUT_TIME_SLOWDOWN
                goto again

'*************END MAIN PROGRAM************
```

Extended Parts List

See scat for resistors, capacitors, and switches.

Note: I do not promote any of these products, I merely state that I used them effectively in this project. To find the electronic needed components, try your local distributors. Also, the electronic part finding program "PartMiner" is very good at finding items.

Material/Item Used	Usage
PVC sheet, 1/8 inch thickness (12" X 18" X 1/8")	Indicator panel, dials, and needles
Styrene Rod, 3/8 inch diameter (12" long)	Indicator needle mounts
Styrene Rod, 1/2 inch diameter (12" long)	Gear shafts
6-32 bolts 1/2 inch (X 6)	Dial fasteners, needle mounts
4-40 bolts 1/2 inch (X10)	Gear shaft lock down bolts, dial lock down bolt, motor mount bolts
BASIC Stamp 2 Micro Computer Parallax, Inc. (X1)	CPU and control
High Linearity Potentiometers (10 turn)	Analog position reading
SPECTROL Model 534 10 turn pot (X2)	
Motor Driver Chip and Associated Circuit Chip: STMicroelectronics Model L6203 (X1)	BS2 signal input to motor position output
Geared DC Motor Barber Coleman Model FYQF63310-9 Geared Permanent Magnet Motor (X1)	Mechanical positioning device
LTC1298 Analog-to-Digital Converter and Associated Circuit Linear Technology (X1)	Conversion of pot's analog DC level to digital signal
UA78L05ACLP Positive Voltage Regulator Texas Instruments (X1)	9VDC to 5VDC low ripple voltage regulation
13-Tooth Metric Gears, Module 1 Stock Drive Products Model A 1M 2MYZ10013A (X2)	Potentiometer gears
48-Tooth Metric Gears, Module 1 Stock Drive Products Model A 1M 2MYZ10048 (X2)	Dial gears



Last of all, this general scheme could be used to simply make a motor turn a shaft until a desired rotational position was reached, in effect replacing the dialed-in value "masterPOTval" with a programming constant. This would cut your project cost by one pot.

As a final note, please notice that the "pulseout" command is favored over the "PWM" command as it simply produces a more controllable, higher torque motor output in this set-up.

I hope that you find this project to be a good start. **NV**

```
'PotTest1.BS2
'This is the program used to get the raw value straight from the LTC1298 Analog to Digital
' Converter By recording (spreadsheet)the values for the master and slave pots at equally spaced
' increments of dial turn one can then determine the multiplier used to "make the two
' potentiometers equal." (See the whole program and the docs for how this multiplier is used.)

DIO_n              con    2              ' Data I/O pin _number_.
CLK                con    1              ' Clock to ADC; out on rising, in
on falling edge.
CS                 con    0              ' Chip select; 0 = active
config             var    nib            ' Configuration bits
                                         ' for ADC.

AD                 var    word           ' Variable to hold
                                         ' 12-bit AD result.

startB             var    config.bit0        ' Start bit for comm
                                             ' with ADC.
sglDif             var    config.bit1        ' Single-ended (1
                                             ' pot) or differential
                                             ' mode.
oddSign            var    config.bit2        ' Channel selection.
msbf               var    config.bit3        ' Output 0s after
                                             ' data xfer complete.


slavePOTval        var    word
masterPOTval       var    word
slavePOTaugval     var    word
masterPOTaugval    var    word

pinCCW             var    byte
pinCLOCKWISE       var    byte


PULSOUT_TIME_FULLAHEAD   var    word
PULSOUT_TIME_MEDIUM      var    word
PULSOUT_TIME_SLOWDOWN    var    word

TICKS_FULLAHEAD          var    word         ' 0-65535 in 2E-6
                                             ' seconds intervals
                                             ' for 0-.131 seconds
TICKS_MEDIUM             var    byte         ' byte is 0-255 for
                                             ' 0-.0005 seconds
TICKS_SLOWDOWN           var    byte



btnWk                    var    bit


PULSOUT_TIME_FULLAHEAD=1500
PULSOUT_TIME_MEDIUM=700
PULSOUT_TIME_SLOWDOWN=300


TICKS_FULLAHEAD=100
TICKS_MEDIUM=50
TICKS_SLOWDOWN=3

pinCCW=15
pinCLOCKWISE=13

'*************BEGIN MAIN PROGRAM*************

btnWk=0

Buttonloop:
BUTTON 11,1,255,0,btnWk,1,startme
goto Buttonloop

startme:
HIGH 8

high CS
high DIO_n

again:

 FOR oddSign = 0 to 1

        config = config | %1011
        low CS
        shiftout DIO_n,CLK,lsbfirst,[config\4]
        shiftin DIO_n,CLK,msbpost,[AD\12]
        high CS

        IF oddSign=0 THEN isZero
        masterPOTval=AD*11                          'CHANGE THIS BACK

        masterPOTaugval=AD



        goto pickup1

        :isZero
        slavePOTval=AD*10
        slavePOTaugval=AD

pickup1:

NEXT

debug "masterPOTval ",DEC masterPOTval," *** slavePOTval ",DEC slavePOTval,cr '<--SHOWS
ACTUAL LTC VALUE
debug "masterPOTaugval ",DEC masterPOTaugval," *** slavePOTaugval ",DEC slavePOTaugval,cr
'<--SHOWS AUGMENTED LTC VALUE

goto again              ' VERY IMPORTANT THIS GOTO...IT KEEPS PROGRAM FROM
                        ' EVER GOING TO STATEMENTS BELOW AFTER CHECKING
                        ' CONDITIONS


'*************END MAIN PROGRAM*************
```

Write in 142 on Reader Service Card.

Open Channel

by Joseph J. Carr

Fiber Optic Technology — Part I

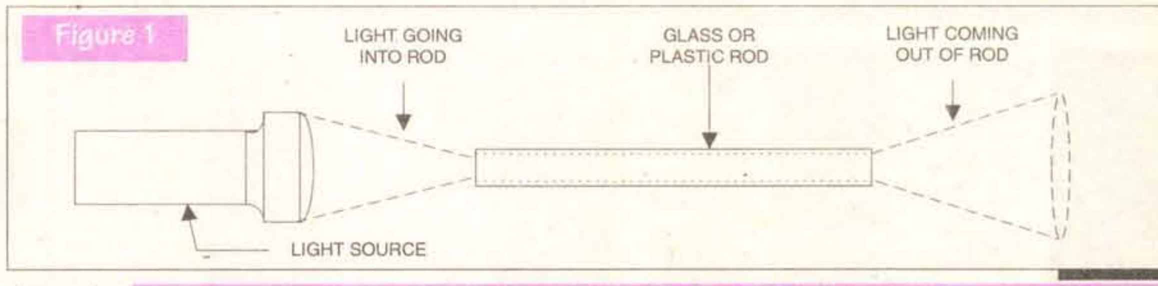
Fiber optics is the latest in communications and instrumentation technology, at least as far as the "wiring" is concerned. Briefly stated, *fiber optics is the passing of light through a plastic or glass fiber so that it can be directed to a specific location.* If the light is encoded *(modulated)* with an information signal, then that signal is transmitted over the optical path. In this month's column, we will take a look at fiber optic technology.

There are many advantages to the optical fiber communications or data link, including:

* Very high bandwidth (accommodates video signals, multiple voice channels, or high data rate computer communications).
* Very low weight and small size.
* Low loss compared with other media.
* No electromagnetic interference (EMI).
* High degree of electrical isolation.
* Explosion proof.
* Good data security.
* Improved "fail-safe" capability.

The utility of the high-bandwidth capability of the fiber optical data link is that it can handle a tremendous amount of electronically transmitted information simultaneously. For example, it can handle more than one video signal (which typically requires 500 kHz to 6 MHz of bandwidth, depending on resolution). Alternatively, it can handle a tremendous number of voice communication telephone channels. A high-speed computer data communications capability is also possible. Either a few channels can be operated at extremely high speeds, or a larger number of low-speed parallel data channels are available. Fiber optics is so significant that one can expect to see it proliferate in the communications industry for years to come.

The light weight and small size, coupled with relatively low loss, gives the fiber optic communications link a great economic advantage when large numbers of channels are contemplated. To obtain the same number of channels using coaxial cables or "paired wires," the system would require a considerably larger — and heavier — infrastructure.



Fiber optic principles were first noted in the early 1870s when John Tyndall introduced members of Britain's Royal Society to his experimental apparatus.

Electromagnetic Interference (EMI) and System Safety

Electromagnetic interference (EMI) has been an annoying factor in electronics since Marconi and DeForest interfered with each other in radio trials for the Newport Yacht Races prior to the turn of the 20th-century.

Today, EMI can be more than merely annoying; it can cause tragic accidents. For example, airliners are operated more and more from digital computers. Indeed, one airline copilot recently quipped (about modern aircraft) that one doesn't need to know how to fly anymore, but one does need to be able to type on a computer keyboard at 80 words per minute. This points out just how dependent aircraft have become on modern digital computers and intercommunication between digital devices. If a radio transmitter, radar, or electrical motor is near one of the intercommunications lines, it would be possible to either introduce false data or corrupt existing data unless the proper precautions were taken in the design. Because the EMI is caused by electrical or magnetic fields coupling between electrical cables, optical fibers, being free of such fields, produce dramatic freedom from EMI.

Electrical isolation is required in many instrumentation systems either for user safety, or to avoid electronic circuit damage. In some industrial processes, high electrical voltages are used, but the electronic instruments used to monitor the process are both low-voltage and ground referenced. As a result, the high voltage can damage the monitor instruments. In fiber optical systems, it is possible to use an electrically floating sensor, and then transmit the data over a fiber link to an electrically grounded, low-voltage computer, instrument, or control system.

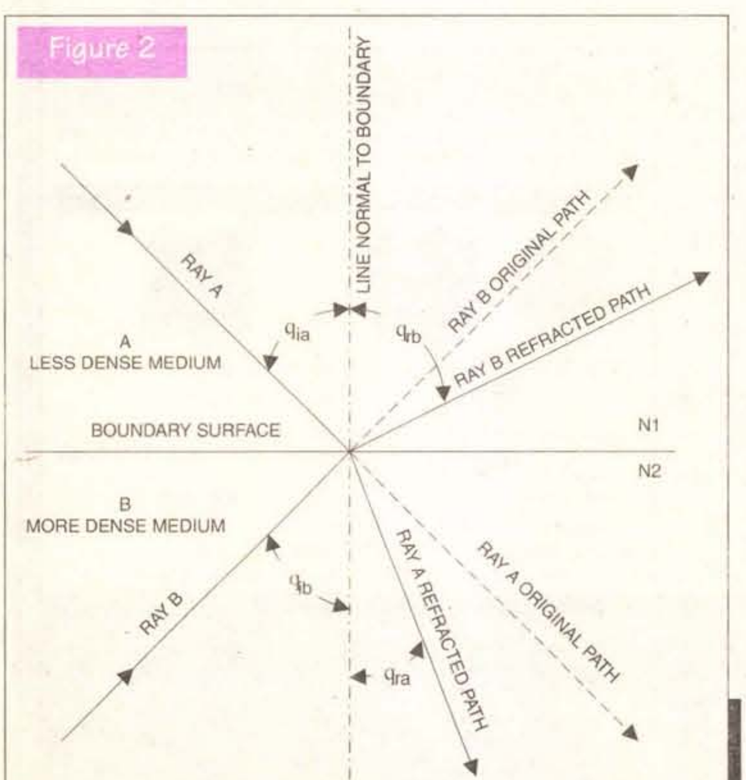
Optical fibers can transmit light beams generated in non-contacting electronic circuits, making fiber optic systems ideal for use around flammable gases or fumes, nuclear power generators, and other hazardous environments. Regular mechanical switches or relays arc on contact or release, and those sparks may ignite flammable gases or fumes. Occasional operating room explosions in hospitals occurred prior to 1980, and electrical arcs in switches have caused gasoline station explosions.

System security is enhanced because optical fibers are difficult to tap. An actual physical connection must be made to the system, resulting in a detectable power loss. In wire systems, capacitive or inductive pickups can acquire signals with less than total physical connection. Similarly, a system is more secure in another sense of the word because the fiber optic transmitters and receivers can be designed "fail safe" so that one fault does not take down the system.

Fiber Optic Principles

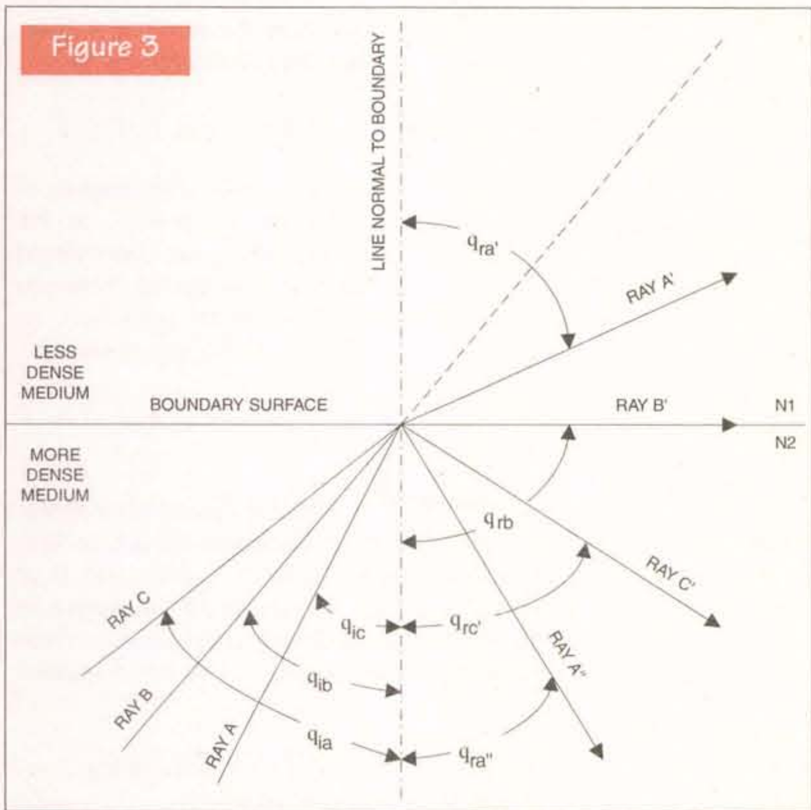
Fiber optic principles were first noted in the early 1870s when John Tyndall introduced members of Britain's Royal Society to his experimental apparatus (Figure 1). An early, but not very practical, color television system patented by J. L. Baird used glass rods to carry the color information. By 1966, C. Hockham and C. Kao demonstrated a system in which light beams carried data communications via glass fibers. The significant fact that made the Hockham/Kao system work was the reduction of loss in the glass dielectric material to a reasonable level. By 1970, practical fiber optic communications were theoretically possible.

Before examining fiber optic technology, it might be useful to review some of the basics of



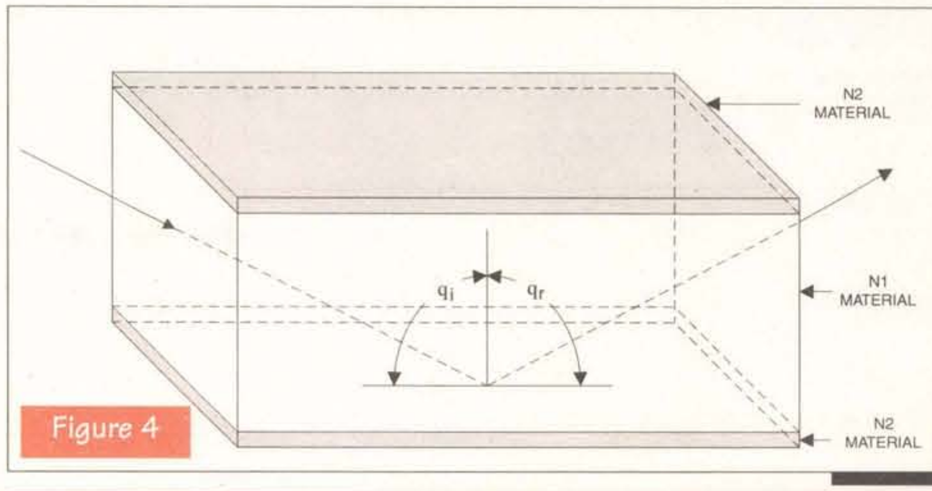
Refraction is the change in direction of a light ray as it passes across the boundary surface, or "interface," between two media of differing indices of refraction.

Figure 3



Of particular concern in fiber optics is the situation of a light ray passing from one medium to a less dense medium.

Figure 4



An optical fiber is similar to a microwave waveguide, and an understanding of waveguide action is useful in understanding fiber optics.

optical systems as applied to fiber optics.

Review of the Basics

The *index of refraction*, or *refractive index*, is the ratio of the speed of light in a vacuum to the speed of light in the medium of interest (glass, plastic, water); for practical purposes, the speed of light in air is close enough to its speed in a vacuum to be considered the same. Mathematically, the index of refraction, n, is:

$$n = \frac{c}{v_m}$$

where,

c is the speed of light in a vacuum (3×10^8 m/s),

v_m is the speed of light in the medium.

Refraction is the change in direction of a light ray as it passes across the boundary surface, or "interface," between two media of differing indices of refraction. In Figure 2, two materials, N1 and N2, have indices of refraction n_1 and n_2, respectively. In this illustration, N1 is optically less dense than N2. Consider incident light ray A, approaching the interface through the less dense medium (N1 $\rightarrow$ N2). As it crosses the interface it changes direction toward a line normal (at a right angle) to the surface. Ray B approaches the interface through the denser medium (N2 $\rightarrow$ N1). In this case, the light ray is similarly refracted from its original path, but the direction of refraction is *away* from the normal line.

In refractive systems, the angle of refraction is a function of the ratio of the two indices of refraction, i.e., it obeys *Snell's law:*

$$n_1 \sin \theta_i = n_2 \sin \theta_r$$

or,

$$\frac{n_1}{n_2} = \frac{\sin \theta_r}{\sin \theta_i}$$

where,

θ_i is the angle of incidence,

θ_r is the angle of refraction.

Of particular concern in fiber optics is the situation of a light ray passing from one medium to a less dense medium. This can be illustrated with either a water-to-air system, or a system in which two different glasses, having different indices of refraction, are interfaced. This situation is shown in Figure 2 with Ray B.

Figure 3 shows a similar system with three different light rays approaching the same point on the interface from three different angles. (θ_{ia}, θ_{ib}, and θ_{ic}, respectively). Ray A approaches at a *subcritical angle*, θ_{ia}, so it will split into two portions (A' and A"). The reflected portion, A', contains a relatively small amount of the original light energy, and may indeed be nearly indiscernible. The major portion, A", of the light energy is transmitted across the boundary, and refracts at an angle $\theta_{ra'}$ in the usual manner.

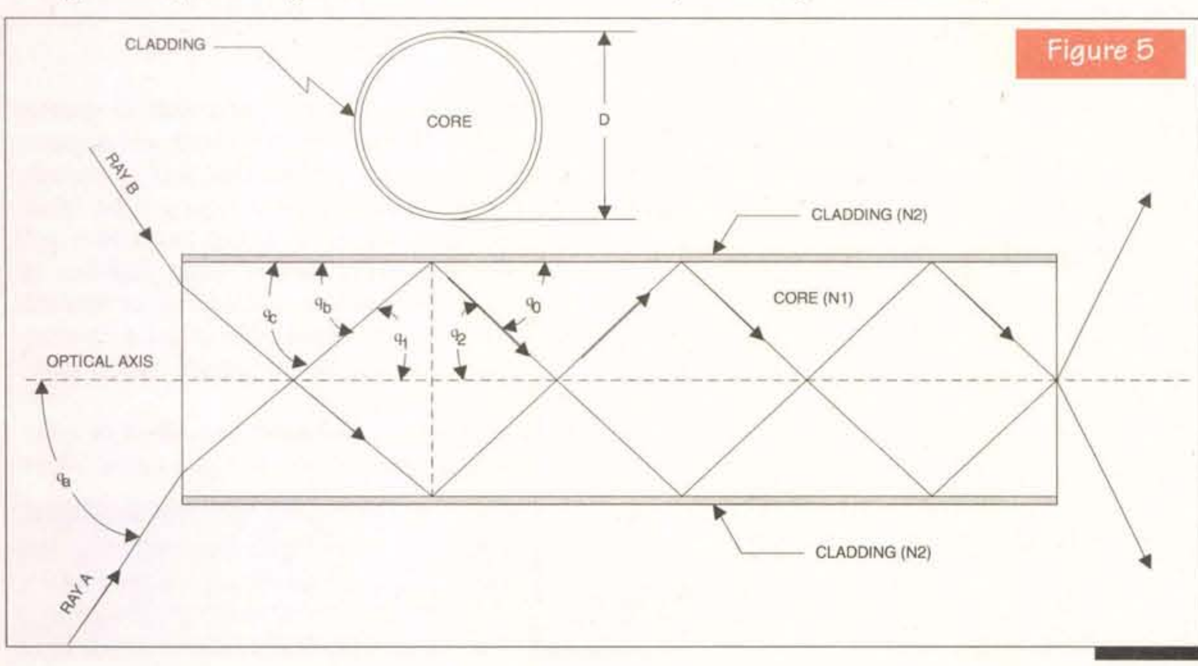
Light Ray B, on the other hand, approaches the interface at a *critical angle*, θ_{ib}, and is refracted along a line that is orthogonal to the normal line; that is, it travels along the interface boundary surface. This angle is labeled θ_c in optics textbooks.

Finally, Ray C approaches the interface at an angle greater than the critical angle, known as the *supercritical angle*. None of this ray is transmitted, but rather it is turned back into the original medium. This phenomenon is called *total internal reflection* (TIR). It is this phenomenon that allows fiber optics to work. TIR is called total internal *reflection*, but it is actually a refraction phenomenon.

Fiber Optics

An optical fiber is similar to a microwave *waveguide*, and an understanding of waveguide action is useful in understanding fiber optics. A schematic model of an optical fiber is shown in Figure 4. A slab of material (N1) is sandwiched between two slabs of a less dense material (N2). Light rays that approach from a supercritical angle are totally internally reflected from the two interfaces (N2 $\rightarrow$ N1 and N1 $\rightarrow$ N2). Although only one "bounce" is shown in the illustration, the ray will be subjected to successive TIR reflections as it propagates

Figure 5



Fiber Optic Technology — Part I

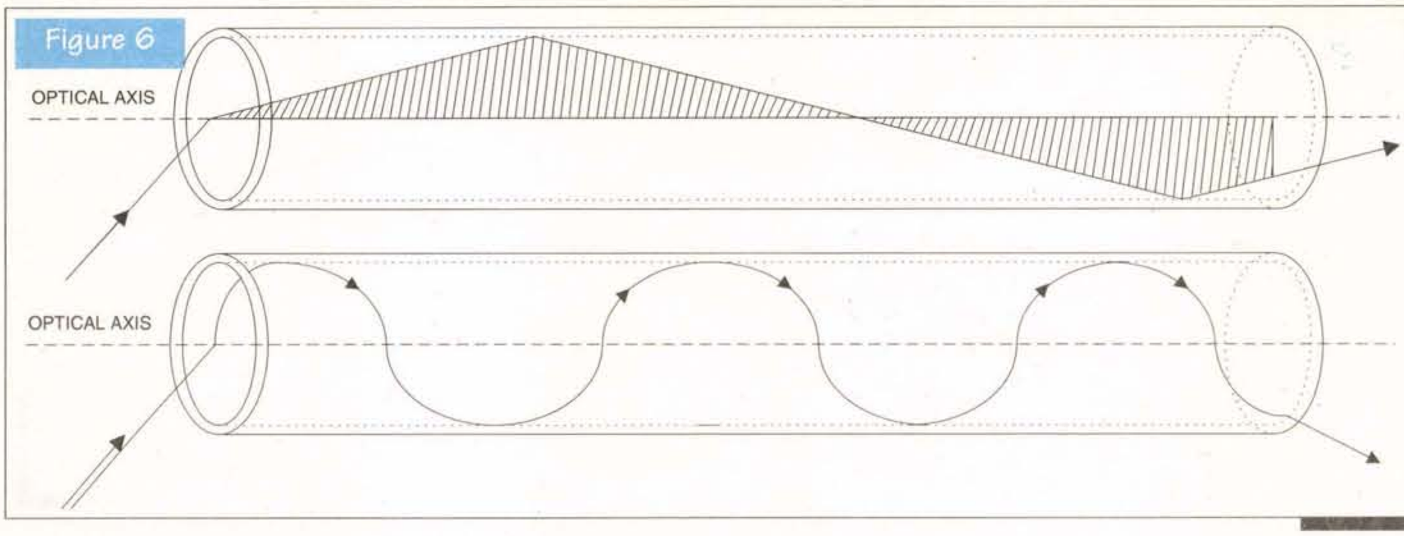


Figure 6

through the N1 material. The proportion of light energy that is reflected through the TIR mechanism is on the order of 99.9 percent, which compares quite favorably with the 85 to 96 percent typically found with plane mirrors.

Fiber optic lines are not rectangular, but cylindrical, as shown in Figure 5. The illustrated components are called *clad optical fibers* because the inner core is surrounded by a less dense layer called *cladding*. Shown in Figure 5 are two rays, each of which is propagated into the system at supercritical angles. These rays will propagate through the cylindrical optical fiber with very little loss of energy.

There are actually two forms of propagation. The minority form, called *meridional rays*, are easier to understand and mathematically modeled in textbooks because all rays lie in a plane with the optical axis (Figure 6A). The more numerous *skew rays* follow a helical path, so are somewhat more difficult to discuss (Figure 6B).

The *cone of acceptance* of the optical fiber is a conical region centered on the optical axis (Figure 7). The *acceptance angle* θ_a is the critical angle for the transition from air ($n = n_a$) to the core material ($n = n_1$). The ability to collect light is directly related to the size of the acceptance cone, and is expressed in terms of the *numerical aperture* (NA), which is:

$$NA = \sin \theta_a$$

The refraction angle of the rays internally, across the air-n_1 interface, is given by Snell's law:

$$\theta_{b1} = \arcsin\left(\frac{n_a \sin \theta_a}{n_1}\right)$$

It can be shown that:

$$\theta_{a1} = \theta_{a2}$$

$$\theta_{b1} = \theta_{b2}$$

$$\theta_{a1} = \frac{\theta_a}{n_1}$$

In terms of the indices of refraction of the ambient environment outside the fiber, the core of the fiber, and the cladding material, the numerical aperture is given by:

$$NA = \sin \theta_a = \frac{1}{n_a}\sqrt{(n_1)^2 - (n_2)^2}$$

If the ambient material is air, then the numerical aperture equation reduces to:

$$NA = \sqrt{(n_1)^2 - (n_2)^2}$$

Internally, the angles of reflection θ_{a1} and θ_{a2}, at the critical angle, are determined by the relationship between the indices of refraction, n_1 and n_2, of the two materials:

$$\theta_{a1} = \frac{\arcsin \sqrt{(n_1)^2 - (n_2)^2}}{n_1}$$

Typical optical fiber materials have numerical apertures of 0.1 to 0.5; typical multimode fibers have diameters D of 25 μm to 650 μm. The ability of the device to collect light is proportional to the square of the numerical aperture multiplied by the diameter:

$$\zeta \propto (NA \times D)^2$$

where,

ζ is the relative light collection ability,
NA is the numerical aperture,
D is the fiber diameter.

Intermodal Dispersion

When a light ray is launched in an optical fiber, it can take any of a number of different paths, depending in part on its launch angle (Figure 8). These paths are known as *transmission modes*, and vary from very-low order modes parallel to the optical axis of the fiber (Ray A), to the highest-order mode close to the critical angle (Ray C); in addition, there are many paths between these two limits. An important feature of the different modes is that the respective path lengths vary tremendously, being shortest with the low-order modes and longest with high-order modes. If an optical fiber has only a single core and single layer of cladding, it is called a *step index* fiber because the index of refraction changes abruptly from the core to the cladding. The number of modes, N, that can be supported is given by:

$$N = \frac{1}{2}\left(\frac{\pi D [NA]}{\lambda}\right)^2$$

Any fiber with a core diameter D greater than about 10 wavelengths (10λ) will support a very large number of modes, and is typically called a *multimode fiber*. A typical light beam launched into such a step index fiber will simultaneously find a large number of modes available to it. This may or may not affect analog signals, but it has a deleterious effect on digital signals called *intermodal dispersion*.

Figure 9 illustrates the effect of intermodal dispersion on a digital signal. When

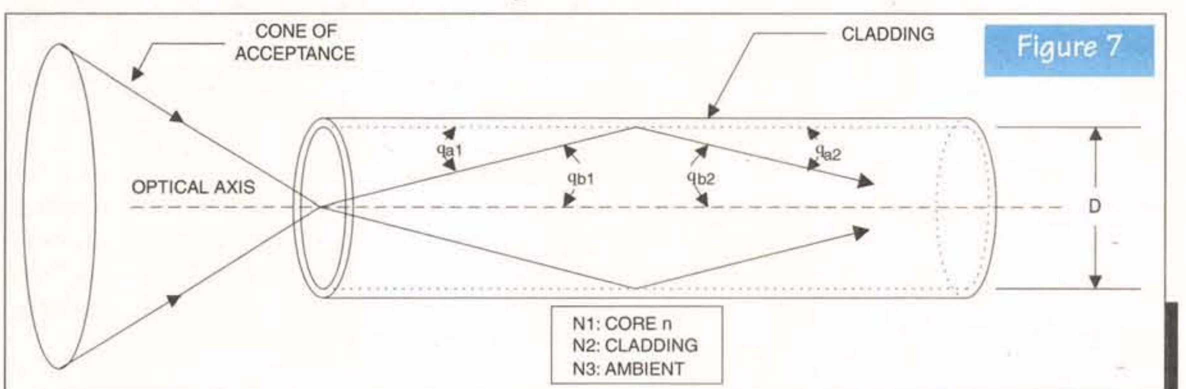


Figure 7

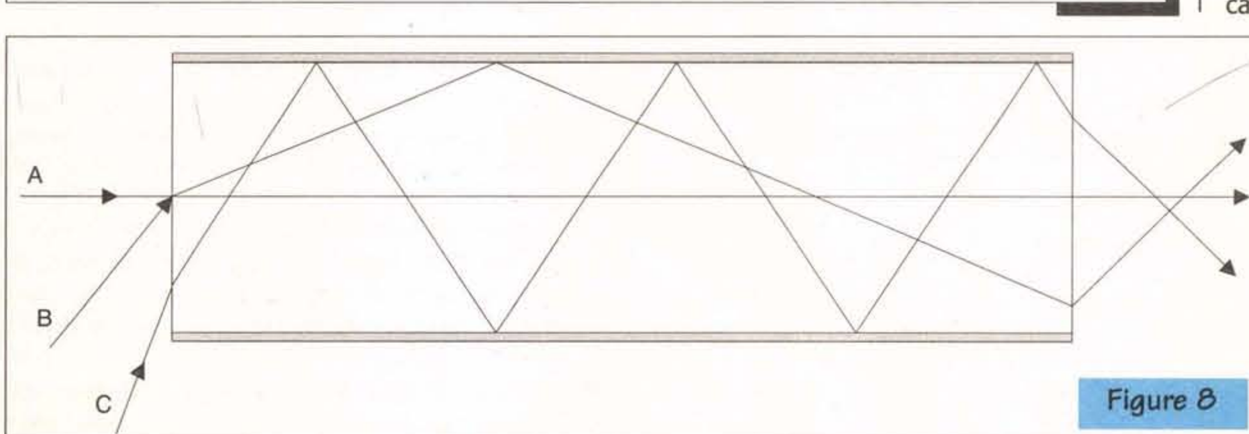


Figure 8

When a light ray is launched in an optical fiber, it can take any of a number of different paths, depending in part on its launch angle

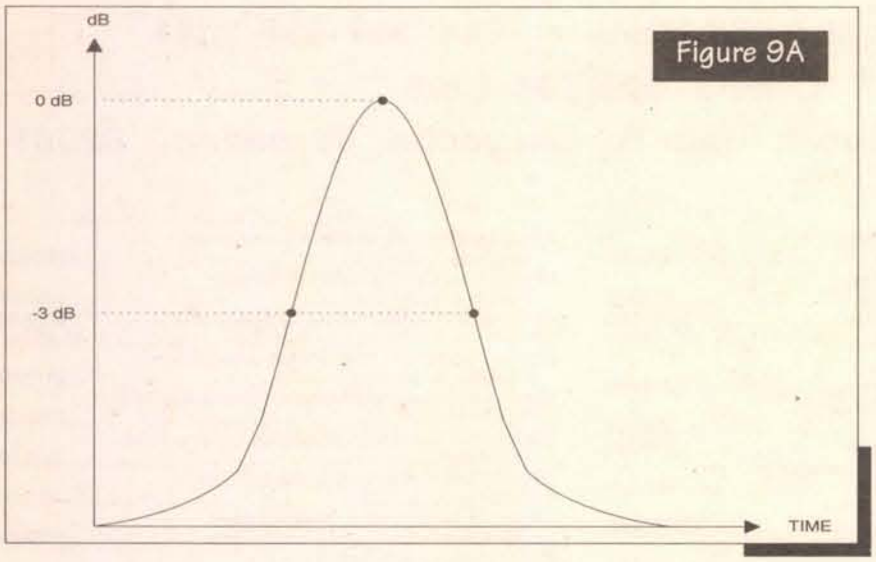


Figure 9A

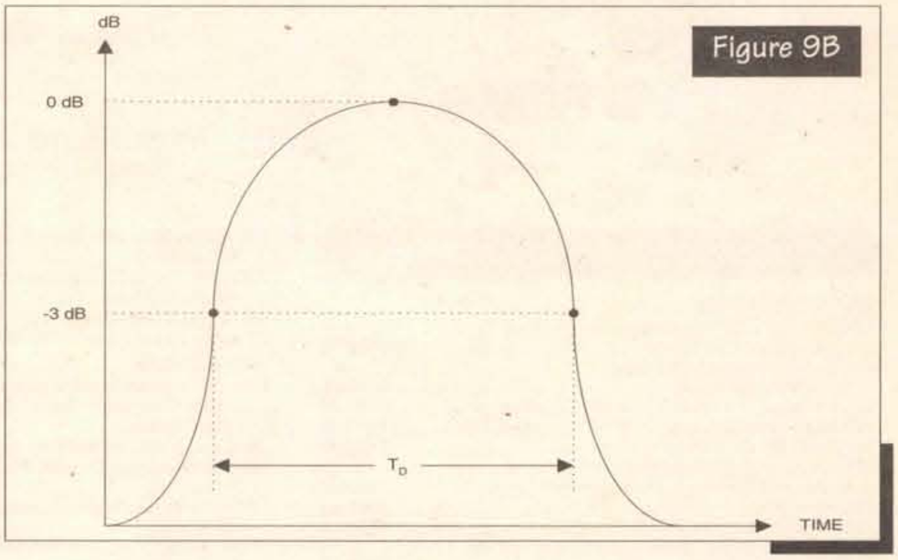


Figure 9B

a short-duration light pulse (Figure 9A) is applied to an optical fiber that exhibits a high degree of intermodal dispersion, the received signal (9B) is dispersed, or "smeared," over a wider area. At slow data rates, this effect may prove negligible because the dispersed signal can die out before the next pulse arrives. But at high speeds, the pulses may overrun each other (Figure 10), producing an ambiguous signal that exhibits a high data error rate.

Intermodal dispersion is usually measured relative to the widths of the pulses at the -3 dB (half-power) points. In Figure 9, the time between -3 dB points on the incident pulse transmitted into the optical fiber is T, while in the received pulse the time between -3 dB points is T_d. The dispersion is expressed as the difference, or:

$$Dispersion = T - T_d$$

A means for measuring the dispersion for any given fiber optic element is to measure the dispersion of a Gaussian (normal distribution) pulse at those -3 dB points. The cable is then rated in nanoseconds of dispersion per kilometer of fiber (ns/km).

The bandwidth (BW) of the fiber, an expression of data rate in MegaHertz per kilometer (MHz/km), can be specified from knowledge of the dispersion, using the expression:

$$BW\ (MHz/km) = \frac{310}{Disp.(ns/km)}$$

Next Month ...

Next month, we will look at the types of defects and losses that one finds in fiber optic systems. **NV**

Connections ...

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NARDA 794FM Direct Reading Variable Attenuator, 0-40 dB, 4-8 GHz ... $375.00
OMNI-SPECTRA 2085-6010-00 Crystal Detector, 1-18 GHz, negative polarity, SMA(m/f) ... $50.00
PAMTECH KYG1014 WR42 Junction Circulator, 18.0-26.5 GHz ... $250.00
SONOMA SCIENTIFIC 21A3 WR42 Circulator, 20 dB, 20.6-24.8 GHz ... $75.00
TEKTRONIX 2701 Step Attenuator, 0-79 dB, DC-1 GHz, AC or DC coupled ... $175.00
TRG B510 WR22 Direct Reading Attenuator, 0-50 dB, 33-50 GHz ... $900.00
TRG V510 WR15 Direct Reading Attenuator, 0-50 dB, 50-75 GHz ... $900.00
TRG V551 WR15 Frequency Meter, 50-75 GHz ... $600.00
TRG W510 WR10 Direct Reading Attenuator, 0-50 dB, 75-110 GHz ... $1,000.00
TRG W551 WR10 Frequency Meter, 75-110 GHz ... $750.00
WAVELINE 100080 WR28 Terminated Crossguide Coupler, 30 dB ... $200.00
WEINSCHEL 150-110 Programmable Step Attenuator, 0-110 dB, DC-18 GHz, SMA ... $450.00
WEINSCHEL DS109 Double Stub Tuner, 1-13 GHz, N(m/f) ... $150.00
WEINSCHEL DS109LL Double Stub Tuner, 0.2-2.0 GHz, N(m/f) ... $150.00

COMMUNICATIONS

HP 4935A Transmission Impairment Measuring Set ... $600.00
HP 59401A HPIB Bus Analyzer ... $375.00
MICRODYNE 1200MR 215-320 MHz Telemetry Receiver, PSK demodulation ... $450.00
TEK 1411R PAL Gen.,w/SPG12 sync;TSG11 color bars; TSG13 linearity ... $750.00
TEK 1411R PAL Test Gen., w/SPG12,TSG11, TSG13,TSG15,TSG16 ... $1,000.00
TEK 1411R PAL Test Gen., w/SPG12,TSG11,TSG12, TSG13,TSG15,TSG16 ... $1,100.00
TEK 1411R-opt.04 PAL Test Gen.,w/ SPG12,TSG11,TSP11,TSG13,TSG15,TSG16 ... $1,400.00
TEK 147A NTSC Test Signal Generator, with noise test signal ... $800.00
TEK 148 PAL Insertion Test Signal Generator ... $700.00
TEK 520A NTSC Vectorscope ... $750.00
TEK 521A PAL Vectorscope ... $750.00

MISCELLANEOUS

EG&G / P.A.R. 5302 / 5316 Lock-in Amplifier, 100 mHz-1 MHz, GPIB / RS232C ... $2,250.00
FLUKE 2180A RTD Digital Thermometer ... $500.00
HP 59307A HPIB VHF Switch ... $200.00
P.A.R. 5206-95,98 Two-Phase Lock-in Amp., 2 Hz-100 kHz, GPIB ... $1,500.00
TEK TM5003 5000-series 3-slot Programmable Power Module ... $450.00
TEK TM5006 5000-series 6-slot Programmable Power Module ... $500.00
TEK TM504 500-series 4-slot Power Module ... $175.00
TEK TM506 500-series 6-slot Power Module ... $250.00
TEK TM515 500-series 5-slot Traveller Power Module ... $250.00

Write in 137 on Reader Service Card.

ELECTRONICS Q & A

With TJ Byers

In this column, I answer questions about all aspects of electronics, including computer hardware, software, circuits, electronic theory, troubleshooting, and anything else of interest to the hobbyist.

Feel free to participate with your questions, as well as comments and suggestions.

You can reach me at:

TJBYERS@aol.com

or by snail mail at

Nuts & Volts Magazine, 430 Princeland Ct., Corona, CA 92879.

What's Up:

Cascading LM3914 chips, more about CueCat, and printer port relay interface defined. Free software, microwave ovens, Win 98 shortcuts — and a reader solves a sticky problem.

Cross-Reference Common Sense

Q. I would appreciate some help with identifying a component from my Black & Decker Cordless Drill, Model #9052 (8.4 volts). It has markings that indicate it is an FET of some type.

EAT11
V337
A circle with an M in the center
Terminals marked g d s

Ted in Atlanta
via Internet

A. I can't find a cross-reference for this part, but you described it well enough that I can make an educated guess as to what's a suitable substitute. First, you're right, it's a power FET (Field-Effect Transistor). The g (gate), d (drain), and s (source) markings are a dead giveaway. I assume it's driven using pulse-width modulation, so the critical parameters are switching time, on resistance, and maximum current. Here comes my guess, and the results of a parametric research using these parameters.

Parameter	My Guess	Search Results *IRF530N*
V(BR)DSS	100V	100V
ID	10A	17A
RDS(on)	0.2 ohms	0.11 ohms
Polarity	N-channel	N-channel
Outline	TO-220	TO-220

The IFR530N is available from **Digi-Key (1-800-344-4539; wwwdigikey.com)** and **Mouser Electronics (1-800-346-6873; www.mouser.com)**, among others.

Free PCB Software!

Q. I have successfully completed prototypes of both circuits you helped me with, and I thank you. Now, I'm wondering if you might know of a printed circuit board design/layout program that is shareware or freeware. I make so little use of these programs that I hesitate to spend very much money on one.

P.J. Hicks
via Internet

A. My favorite freeware PCB layout programs is EasyTrax from Protel. The program originally sold for $100.00, but as the Protel family of EDA products grew, they decided to donate this fine application to the public domain. As a result, Protel no longer has technical support for this application, but I doubt you'll have any problems learning and using it. (BTW, Protel makes CircuitMaker 2000, which I use to draw the schematics and create foil patterns that you see in this column.) You can find EasyTrax at **www.protel.com/etech/freeware_home.html** or from our web site (**www.nutsvolts.com**) under the name EASYTRAX.ZIP. Although it's a DOS program, it runs smoothly under Windows 95/98.

The Scoop on CueCat

Q. I read with interest your reference to the RadioShack CueCat bar code reader in your Nov. 2000 column. I went to the web site listed (**www.radioshack.com/Partners/CAT/HomePage/RSCATGateway.asp**) and found a general description of the CueCat, but no "behind the scenes secret." Exactly where do I find this "secret?"

Jim
via Internet

Q. In a recent issue, you mentioned a behind the scenes secret for CueCat. I am a college professor that teaches very large lecture classes and want to use a bar code reader to input student assignments, etc. I can get the labeling software free off the Internet, but how can I make the CueCat input this into some type of spreadsheet like Excel? Any help is appreciated — I did not find the secret on the referenced web site.

Joe Valencic
via Internet

A. Ready to play with your CueCat? Here are the files you'll need:

Hardware solutions

www.flyingbuttmonkeys.com/mirrors/www.net-noise.com/jshenry/cuecat_mods/cuecat_mods.html

http://air-soldier.com/~cuecat/5minute.html

Software solutions

www.flyingbuttmonkeys.com/foocat/

www.beau.lib.la.us/~jmorris/linux/cuecat/

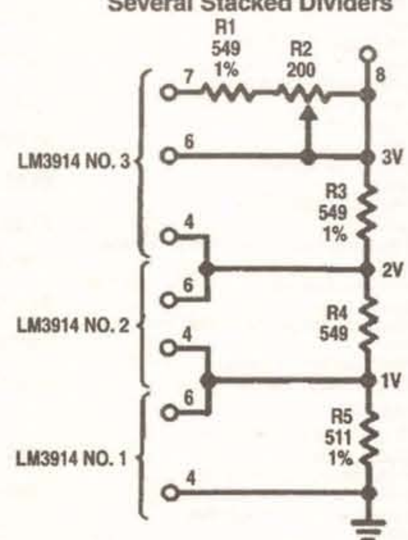
Cascading LM3914 Chips

Q. I need a circuit designed around the LM3914 chip to monitor a 0 to 5 volt DC input. I further want it to have three LM3914 chips cascaded so they will support 30 LEDs in the dot mode. Can this be done?

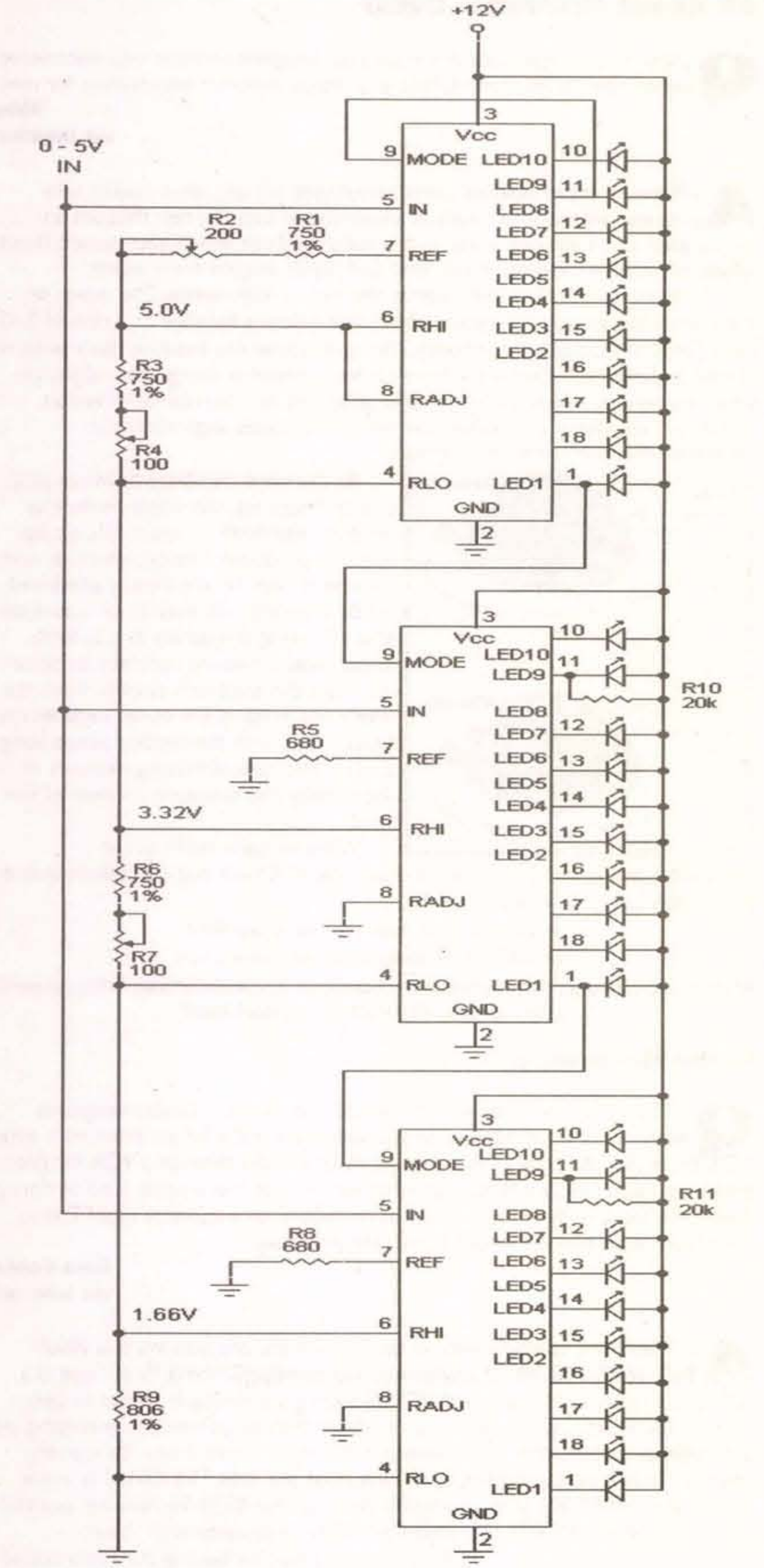
Rod Smith
via Internet

A. There is no limit to the number of LM3914 chips that can be cascaded, but after the second chip, you'll have a problem with linearity and skew as the voltage shifts from one chip to another. Basically, the input voltage has to make a smooth transition from one LM3914 to the next, otherwise more than LEDs will be lit. The problem is finding a way to fine tune each LM3914 without affecting other adjustments. Here's what National Semiconductor recommends.

Adjusting Linearity of Several Stacked Dividers



In this scenario, the top LM3914 outputs a constant current through the R3, R4, and R5 resistor ladder. To calibrate and linearize the voltage scale, R2 is adjusted so that there is 1 volt across R5. This establishes the brightness of the LEDs and the reference current. To fine tune the remaining two 3914's, National has you parallel 6k chips across R3 and R4 until they read the indicated voltages (thus compensating for the inevitable resistance variation between resistors). Now here's my version.



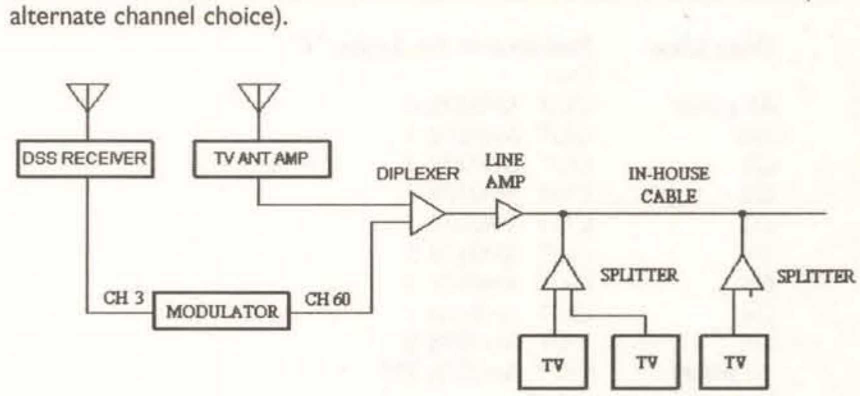
In my circuit, I placed a variable resistor in series with R3 and R6. While it's more sensitive to vibration and temperature extremes, it's easier for the hobbyist to build and calibrate. The calibration procedure is the same: adjust R2 so that there is 1.66 volts across R9, adjust R7 for 3.32 volts from R6 to GND, finally adjust R4 for 5.0 volts from R3 to GND. If you prefer the National approach, replace R3 and R6 with fixed 845-ohm, 1% resistors, and bridge with combinations of 47k resistors to tweak them in.

Mixing TV and Satellite Dish

Q. I would really like a circuit that could take my broadcast TV antenna signals and pass them through except for channel 3, and then use channel 3 for the output of my satellite dish. That way, one coax could run throughout the house and any TV on it could watch satellite or local TV without having to run two cables or use a switchbox.

John Hanson
Lakewood, CO

A. What you need is a video modulator — basically a video frequency converter. This device converts channel 3 (or channel 4) from your satellite dish into channel 60 (439.250 MHz). The modulator's output and TV antenna are then combined in a device called a TV diplexer (RadioShack 16-2581), and output to the in-house coax cable. The mixed signals are then amplified using a standard line amplifier (RadioShack 15-1113). The amplifier is necessary to make up for loses in the splitters and cable length, so don't skip it. Now you can use a single cable to provide service to every set in the house. Just like before, you tap into the cable using a splitter. The TV channels will all work as before, and the satellite dish can be found on channel 60 (or alternate channel choice).



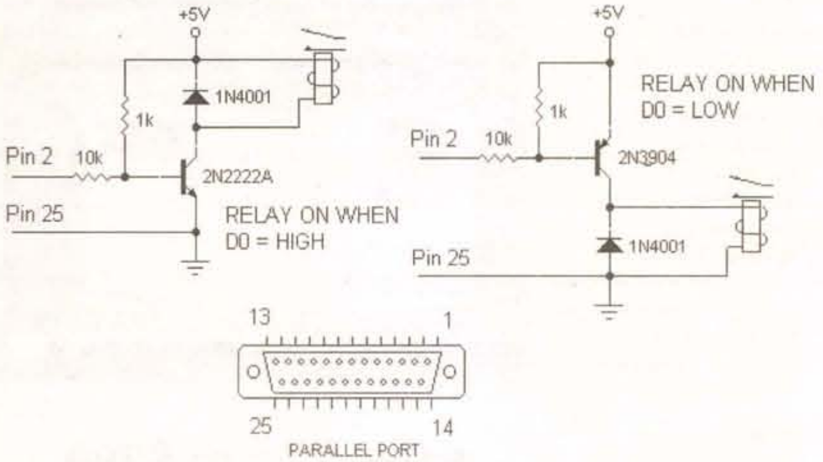
Video modulators are available from most DSS distributors, including **Satellite Warehouse (1-800-851-6534; www.dbs-online.com/index.html)**, and **Star Link (405-745-9222; www.starlink-dss.com)**.

PC-Controlled Cassette Recorder

Q. I would like to send files from the parallel printer port of my PC to my cassette tape recorder. I used this recorder with an old PC that had motor on/off commands (the recorder has a motor on/off input jack), but my new PC doesn't have this capability and I can't find what QBasic command to use or how to interface the parallel port to my recorder. Do you have a simple circuit and its related program commands?

Jim L.
New Port Richey, FL

A. Turning the recorder's motor on and off is simple, exporting files to the recorder is another story altogether. Let's start with the motor control, which we'll manage using a small relay and two lines of code. Here are two examples of controlling a relay from the parallel printer port.



Pin	2	3	4	5	6	7	8	9	18 - 25
Function	D0	D1	D2	D3	D4	D5	D6	D7	GND

```
OUT &H0378,0      ;sets D0-D7 low
OUT &H378,255     ;sets D0-D7 high
```

The top circuit uses positive logic to activate the relay and the lower circuit uses inverted (negative) logic to turn on the motor. Both circuits require an external 5-volt power supply that has a common connection to the parallel port's ground pins (pins 18 - 25). The 10k resistor limits the base current through the transistor, and the 1k resistor is there just in case your printer port uses open collector outputs (often called a pull-up resistor). Writing a zero (0) to the port's base address (hex 0378) will set all the data lines (D0 through D7) low, and writing a 255 to the base address will set all the data lines high. Depending on which relay configuration you use, this will toggle any relay connected to D0-D7 between open and closed. The commands listed are for QBasic.

As for outputting files to the recorder, it can't be done without some kind of modem. You see, your files are digital and the tape recorder is audio analog. There was a time (when T. Rex roamed the land) when PCs like Commodore and RadioShack used audio cassettes to store their software applications, but these systems were specifically designed to import and export data using PSK (phase-shift keyed) modulation, much like the early low-speed modems. Today's files are far too large for practical storage on an audio media, especially a cassette. This is why the floppy disk was invented as a platform for removable data storage, transport, and archive.

(Note: For those readers who would like to pull the data lines high individually, here's a table of the instruction codes. — TJ)

Data Line	Instruction for Logic "1" Out
All LOW	OUT &H0378, 0
D0	OUT &H0378, 1
D1	OUT &H0378, 2
D2	OUT &H0378, 3
D3	OUT &H0378, 4
D4	OUT &H0378, 5
D5	OUT &H0378, 6
D6	OUT &H0378, 7
D7	OUT &H0378, 8
All HIGH	OUT &H0378, 255

Floppy PIC Interface?

Q. I would like a program or a flowchart to use with a 16F874 PIC microcontroller to write data to and read data from a 3.5" floppy drive. It must follow IBM standards so the data put on the disk from the PIC can also be read by a PC and copied onto the PC's hard disk drive.

Luke Barker
via Internet

A. Years ago, you could buy a stand-alone chip that would be the front-end for the floppy drive and provided the eight-bit data to the CPU. Now that everything is integrated, that chip is no longer available. Even if you could manage to create the data buffers and timing pulses needed to control a floppy drive, the 16F874 isn't fast enough to keep up with the data flow.

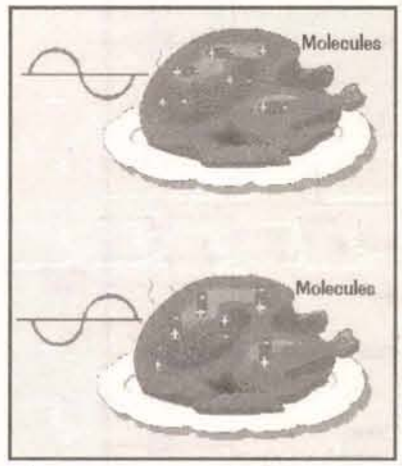
All About Microwave Ovens

Q. For a scavenger hunt in a class, I am assigned to learn why microwave ovens don't burn paper. Could you please describe microwaves for me?

Abby
via Internet

A. Because paper doesn't contain moisture. It's the same reason why glass and plastic won't melt in a microwave oven. To test this, put an empty glass and a glass of water in the nuker and see which gets hotter. That's why a microwave oven can cook food and paper doesn't burn: water!

To illustrate the principle, look at the two turkeys below. The waves of the microwave energy are cycling above and below a baseline at a rate of 2.45 GHz (2450 million times a second). The cycle above the baseline has a positive charge and the cycle below the baseline has a negative charge. This aligns the water molecules, which are electrically polarized, in a horizontal direction. When the waveform is reversed, the water molecules align vertically.



As the wave oscillates between positive and negative, the water molecules flip back and forth — much like a magnet. This produces friction, which, in turn, generates heat. So, the heat is produced inside the food, not outside of it as is the case of baking the turkey in a conventional oven. However, contrary to popular belief, the food isn't cooked from the inside out. Instead, the outer surfaces are heated first, with the heating penetrating deeper. The rate of heating depends on the density and moisture content of the food.

Want to learn more about microwave ovens, including how to repair them? Check out the following web sites. (Don't do this at home, kids!)

www.amasci.com/weird/microexp.html
www.howstuffworks.com/microwave.htm
www.howstuffworks.com/framed.htm?parent=microwave.htm&url=http://www.gallawa.com/microtech/how_work.html

Radio Recording

Q. I hope you can help me. We would like to record radio programs while we are not here — as you would record a TV program with your VCR. We know the trick of running the radio's audio through a VCR for programmed recording, but that's not what we want. Is there some kind of timing device we can buy that would allow us to record on a cassette tape? This is important to us and we would appreciate your help.

Reta Cooke
via Internet

A. There are several solutions to this, but the one you want is **Reel-Talk (678-393-9072; www.reeltalk.com/pg2.htm)**. Reel-Time is a self-contained AM/FM radio with VCR-like program timing. It comes in two models: the RT-101, which allows up to four hours of continuous recording on each side of a standard C-120 cassette tape (eight hours if you flip it over), and the RT-201 which records up to one hour per side. The RT-101 is voice quality, and the RT-201 is music quality. Both sell for $139.95. Another possibility is the Roberts, RC828 PLL digital world radio cassette with timer.

Other solutions involve loading the radio sound on the PC's hard disk in RealAudio, WAV, or similar audio formats. It works by plugging your radio's audio output, normally through the earphone jack, into the PC's sound card. Load up the software, program your times, and that's it. Here's a short list of web sites for this method.

Cybercorder 2000
http://skyhawktech.com

DART Timer Recorder
/www.programfiles.com/index.asp?ID=808

VCRadio 1.2a
www.hitsquad.com/smm/programs/VCRadio_win32/

Keyboard Shortcuts

Tired of mousing around in Windows 95/98? Here are three keyboard

Cool Web Sites

The newly assembled Space Station, now with its solar panels deployed, is the second brightest object in the sky, only behind the moon and the star Sirus. How do you find it in your night sky?
http://liftoff.msfc.nasa.gov/temp/StationLoc.html

Images of the Earth as seen from space. Three animations composed from real weather satellites.
http://www.astrovis.com/gallery/qt/luis_b.html

shortcuts that will save you time and give your wrist a rest.

If you don't rely on your keypad for data entry, you can launch up to 10 applications by assigning the numbers to a shortcut. First, make sure the NumLock is on. Then highlight the program you want to launch, either from a Desktop icon or from the program's listing in the Settings/Taskbar & Start Menu/Start Menu Programs/Advanced menu. Click the right mouse button and choose Properties. Open the Shortcut tab, and click once in the Shortcut Key option. Press the keypad number you wish to assign to the application and click OK. The next time you press that keypad number, the application will be loaded.

To minimize all windows and give you instant access to your Desktop, press the WinKey (the flag-waving key between Ctrl and Alt) and tap D. To restore all windows, repeat WinKey+D.

Windows Explorer can be displayed by pressing WinKey+D; Find can be enabled by pressing WinKey+F.

MAILBAG

Hi TJ:

Many months ago, I wrote you about how to remove the windings from used ferrite cores for use in future projects. You suggested to soak them in a solvent to dissolve the varnish. I tried everything, including MEK, acetone, naphtha, xylene, toluene, and more, all to no avail. I could almost hear them giggling at me from the bottom of the stuff. However, I did find two methods that do work

Heat: This is my favorite and the one I use most. Put the cores inside a small 35mm metal film can, toss the can into a toaster oven, and heat it to around 400° F. Obviously, you need something like leather welders gloves to hold them while removing the windings. This method seems to work the best, and to my surprise, most of the bobbins made in the last couple of years seem to survive the high temperatures unscathed.

Methyl Chloride: Found in many furniture paint strippers, this chemical method works pretty well, too — but with some caveats. The gooey stuff can't always get into the inner core. And the caustic paste burns on the skin unless you use durable rubber gloves. (Be aware, methyl chloride can dissolve latex and Nitrile plastics; I finally settled on an old pair of lineman's high voltage rubber gloves.) Be sure to follow the directions and precautions on the can.

One more point: Even though they look pretty durable, you have to treat them as if they were made out of glass — especially when heating. Unless the heat is slow and even, the brittle core will crack or shatter like a large chunk of glass that's unevenly heated.

Steve Varmecky
W3IOD

CORRECTIONS

In the Nov. 2000 column, it was printed that the resistance of #12 copper wire is 1.59 ohms per foot. Actually, it is 1.59 ohms per 1,000 feet. Similarly for stainless steel wire, at 76.98 ohms per 1,000 feet.

VCR Recording of Radio Programs

You may not know this, but you can record radio shows using your VCR. It's easy and has the advantage that you can record up to eight hours of sound per session — far longer than the 60 minutes audio cassettes offer.

First, start by plugging the radio's audio output into the Audio In (right) and Audio Out (left) inputs of the VCR. They are probably located on the front, but older VCRs put them on the back. Most commonly, the radio output is tapped into via the earphone jack, in which case, you'll need a Y-adapter, like the RadioShack 42-2475.

Second, change or set the VCR's input selection from Tuner to Line or Line In. This maybe done via switches under the front dust cover, or by bringing up the programming menu, depending on your particular VCR. Check the manual if in doubt.

Third, turn the TV set on and tune the radio to the station you want to record and set the volume level.

Fourth, set the timer for the hours the program will run. Virtually all VCRs let you set a start and stop time. If your VCR provides multiple recording sessions (and which don't), program them according to your schedule. At this point, you can turn the TV off; it's no longer needed.

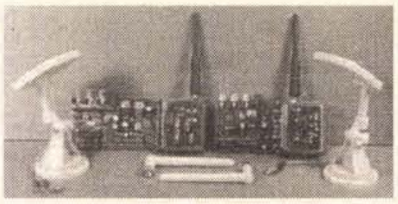
Relax, you're done.

HAM GEAR FOR SALE

WANTED: MILITARY capacitors, resistors, transistors, diodes, ICs, semi's, etc. Please fax/E-Mail excess lists & RFQs 818-769-1002 fax 818-769-1084. electmatind@earthlink.net & http://www.militarycomponents.com

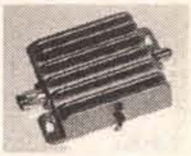
WANTED: ROCKWELL-Collins HF-80 equipment, 851S-1, 237B-3 log periodic, Collins literature. Jim Stitzinger 805-259-2011, 805-259-3830 (fax), bfl-jfs@smartlink.net

MOHAWK AMATEUR 40-10M RF power amplifier Model 7A. $199 delivered. Peter 248-669-3604, fax 248-669-3411. stratigiccontrol@hotmail.com



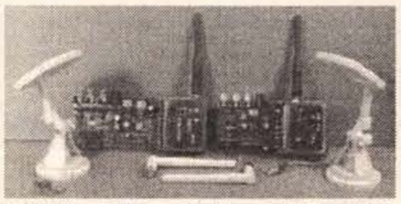
2.4GHz ATV — 8 channel TRANSMITTERS AND RECEIVERS. 35mW output power, 1 video channel, 2 audio. SMA connectors. NTSC/PAL compatible. Includes 1/4 wave rubber duck antenna. Standard frequencies are: 2398, 2405, 2412, 2416, 2420, 2428, 2435, 2442 MHz. Custom frequencies are available. See ad in this section for power amplifier. **$79/each for transmitter. $79/each for receiver.** EzATV. Visit our web-site for dealers or order on-line at www.4atv.com

TXRX 900MHz duplexers 890-960MHz 600 watt duplexers, $110/ea or $99/ea (2 or more). These are new units with circulator & load. www.amtronix.com Ph. 716-763-9104.

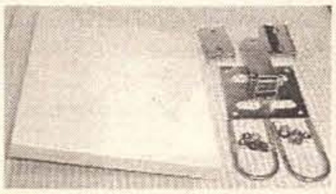


2.4GHz POWER amplifier with power supply. 10-40 mW input, 1 (one) watt output with in-line SMA connectors and built-in heat sink. Approx. 2" x 2" x 5/8" size. Frequency range 2.3GHz-2.5GHz. **$189/each.** Compatible with all ATV product lines. See our website for more info on accessories and transmitter and receiver modules. EzATV. Visit our web-site for dealers or order on-line at www.4atv.com

FOR SALE: TPL COMMUNICATIONS VHF AMPS. Model number PA3-1AE-2. Solid-state amplifiers FM mode 136-175MHz. 3 to 6 watts in 80-120 watt out ... run on 13V 18 amps. With copy of manual, excellent condition, tested, good for 2 meter use $100 ea. Call John 303-341-2283. A-Comm Electronics.



1.2GHz ATV — 8 channel TRANSMITTERS and RECEIVERS. 75mW output power, 1 video channel, 2 audio. SMA connectors. NTSC/PAL compatible. Includes 1/4 wave rubber duck antenna. Standard frequencies are: 1250, 1255, 1260, 1265, 1270, 1275, 1280, 1290 MHz. Custom frequencies are available. **$79/each for transmitter. $79/each for receiver.** EzATV. Visit our web-site for dealers or order on-line at www.4atv.com



SUPER HIGH GAIN 14 dbi flat antenna with N or SMA connector tuned for 2.3-2.5 GHz. Use with 2.4GHz ATV 8 channel transmitter or receiver. **$179/ea.** SPECIAL PRICE. EzATV. Visit our web-site for dealers or order on-line at www.4atv.com

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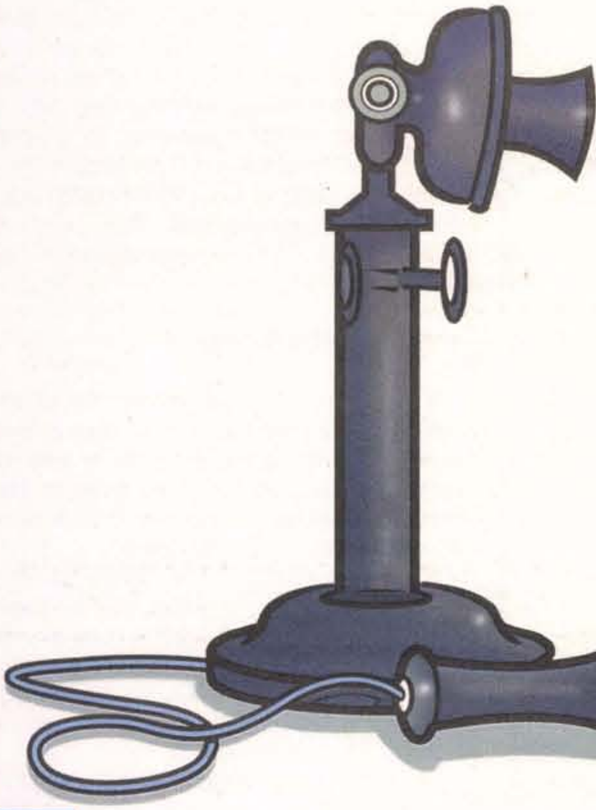
Continued on page 55

Write in 34 on Reader Service Card.

Internet Telephony 101



The concept of Internet telephony has been around for almost as long as there's been a World Wide Web, but has never taken off in the same way that some aspects of the web, like text-based chatting, streaming video, banking at home and other applications have. Even so, several million people are currently using the web to make at least some of their calls, to other PC users and to people with regular telephones on the other end. Want to join them?

If your answer is "Why would I want to make calls on my PC?", the reason is Internet telephony's flexibility, low cost, and definite coolness. Want to call someone on the other side of the country for a penny a minute (or free if they also have an Internet phone), or call Europe at a rate much cheaper than conventional phones? Want to add a second (or third, or fourth) phoneline for peanuts? An Internet phone will do that. Want to avoid getting banged with charges each time you make an outgoing call from your hotel room? If your hotel room has a DSL line, use an Internet telephone.

Back in the Dark Ages of 1995

Those of us who take high-speed Internet connections, fast processors and other switched-on, souped-up, multimedia PC capabilities for granted need to go back – way back – in time to the dark ages of 1995, when the net was still a novelty and Windows went from a version number to a having a year in its name.

Yap Gear Headset Phone

Because – according to Sarah Hofstetter, the Vice President in charge of Corporate Communications for Net2Phone, one of the leading Internet telephony firms – it was in late 1995 when a handful of software providers created programs that made it possible to make voice calls from one computer to another computer. "The benefit," Hofstetter says, "was that you could make calls from one computer to another for free.

The downside was that you both had to be online at the same time. You needed a multimedia PC, which wasn't as widely available at the time as it is today." You both needed to have the same kind of software, which translated voice into IP (Internet protocol), the language of the web.

Of course, in 1995, the speed of the average Internet connection was more than a little poky, with 14.4 and 33.3 kilobyte per second modems the norm. And the slower the Internet connection, the funkier your call sounded.

The complexity of getting started, and the poor sound quality explains why Internet telephony never really took off, the way flashier, sexier web applications have.

But with the growth of high-speed, always on, fat pipe, smokin' Internet connections like DSL and cable modem, Internet telephony starts to look more and more enticing, for both home and small business usage. Especially because PC to "regular" telephone calls are now possible, too.

But what equipment do you need? Are there prepackaged Internet phones, or do you have to cobble together a rig from scratch? What's the minimum speed Internet connection you need so your call won't sound as if it's connected to rusty tin cans and a greasy worn-out string? And what are some other methods of mating the Internet and the telephone?

Getting Started With Internet Telephony

For most home or small business users, the easiest way to access Internet telephony is to start with a PC plugged into the Internet via a dial-up line, or ideally, a high-speed connection like cable modem or DSL. Net2Phone recommends a modem with a minimum of 28.8 kbps, and even that is pushing things. Hofstetter says, "Anything high-speed, like Broadband or T-1 would work great. Cable modem would be fantastic, DSL's great. But on a more common 56k connection, your Internet calls will be experiencing about a third of a second delay. But we do it all the time, and most of our users are using dial-up connections."

Plugged into the net should be a computer with a reasonably fast processor (anything under 300 MHz might be too slow), a decent amount of RAM (64 MB is really the bare minimum for this stuff), a soundcard, speakers, and Windows 95 or higher.

Assuming your PC meets those basic requirements (and most off-the-shelf PCs bought in the last couple of years do), at this point you have some choices to make. If your PC has speakers and a microphone, or if you've got a multimedia headset, with earphones and a mike, either of these schemes can be used to make calls. And, if this approach sounds appealing, appropriate software can be downloaded from Net2Phone, iConnect, BuzMe, or any one of numerous Internet telephony providers. They can be found on most Internet search engines under "Internet telephony."

Turnkey Telephony

Don't want to create an Internet phone from scratch? Use a prepackaged, turnkey approach instead. Net2Phone has a couple of Internet phones that simply need to be plugged into your computer, available at many computer stores under their Yap Gear brandname.

One of the units is a telephone handset style phone, the other is a headset. The handset phone plugs into a computer's USB port, and is styled with a sort of a Populuxe 1950s retro look, making it appear both futuristic, and vaguely dated, as if it were designed by Raymond Loewy in partnership with George Jetson. The headset phone, manufactured by Plantronics, plugs into a PC's soundcard, and looks like a slightly more substantial version of a typical multimedia PC headphone/microphone. The headset phone will replace a computer's external speakers, unless a y-cable and a pair of speakers with an on/off button are also used.

Yap Gear Handset Phone

Both flavors of Yap phones come with Net2Phone software, and their proprietary calling card with $10.00 worth of prepaid calls on it. With free phone calls to other computers, and calls to "real" telephones at one cent a minute within the US, those $10.00 can go a long way. Additional funds can be added to an account via Net2phone's online interface, using credit card or check.

The Net2phone software also allows your PC to send faxes via the Internet, which is free within the US. While the fax interface is clumsier than the more expensive (and dedicated to the task) WinFax, the faxes arrive looking equally crisp and clear. For those PC owners who lack telephone modems (which are becoming more and more common in these days of high-speed Internet connections), the Yap Fax capability could be welcome indeed.

How Does it Compare With a 'Real' Phone?

Okay, so you've got the hardware (of some sort) plugged into your PC. And you've got the software installed. What can you expect?

One thing you can expect are occasional microscopic, but noticeable delays when talking. Tom Jenkins, a director of TeleChoice, a telecommunications consulting firm, says, "Your PC wasn't designed for this, so there is some churning, some processing and some compression, and all these other things it has to do. So, if you're running the Internet at the same time, and you're

Alternative Avant-garde Telephony

Internet Telephony is not the only new trend to come along to snap telephones out of their 100-year, voice only, analog slumber. One such trend is WAP. No, WAP isn't some S&M technique. It stands for wireless access protocol. And, while up to now, we've talked about adding voice to the computer's normal data transmission lines, WAP adds Internet data to established wireless voice transmissions.

Tom Jenkins says, "WAP will dramatically increase the amount of Internet telephony. A lot of people believe (I'm one of them) that wireless cellular solutions are going to be huge for the Internet telephony business. It just makes too much sense if I'm already on the digital (voice) network to combine it with a data network, and allow me to get the person's number and their last email download and their contact information. And to do all of these speech to text and text to speech things that allow me to stay on the cell phone longer, and do all of these other things."

WAP is already a phenomenon in Europe, but it's not yet as dominant in the US. Don Van Doren is the President of Vanguard Communications Corporation (www.vanguard.net) which consults with numerous Fortune 500 businesses on call center and web commerce issues. He says that one reason why it was easier for WAP to take off in Europe is that Europe's infrastructure has more top-down control by their governments. In contrast, "The US is a real mess, because of all the different technologies we're deploying here. Part of the problem is that we've got to deploy multiple parallel services, to figure out whether or not we're doing GSM or CTMA or GTMA or all of these other various protocols that are out there. And that's just nonsense."

However, there are some firms that are betting that any technological challenges will be overcome, and the mobile Internet will change society — and commerce — as much as its hard-wired version did.

M-Commerce

One such company is Snaz, founded in March 1999 as a web and wireless commerce solution firm. Snaz provides its retail partners with the software needed to conduct business over the Internet, as well as via cell phones, PDAs, and other wireless devices. Snaz has agreements with several potent names in both American Internet and "bricks and sticks" retailing, and is also working to add European merchants to its roster.

For the consumer, Snaz promises a single shopping cart to use to shop at a variety of web sites, a nice feature to have with e-commerce, but a huge benefit for m-commerce (mobile commerce). "When you were ready to buy," Vikram Chachra, Snaz's CEO says, "we would actually enable you to buy from multiple merchants, all with a single checkout experience." And although m-commerce clearly has more of a need than e-commerce for the single shopping cart approach, it remains to be seen how many people will use their cellphones and PDAs to shop online.

Cable Telephony

Another new twist on plain old telephone service is cable telephony. Don't be surprised to see statement stuffers for telephone service in your local cable company's monthly bill, a result of mid-1990s deregulation by the FCC. Cable modem manufacturers have created boxes that can split off telephone signals to send them to a home's telephone network. And these are rolling out in more and more areas by a variety of cable companies, such as Cox Cable in San Diego, CA, and Time Warner Communications in Rochester, NY.

Will cable telephony show up at your home? In some areas, issues like local regulations and competition may slow or prevent it. However, cable telephony is clearly a growing trend, as cable companies begin to offer telephone service, and phone companies (like AT&T) begin to buy cable providers.

sending and receiving email, and doing all these other things that's making it process, the quality can be degraded."

Which means that the degree of quality you receive can vary widely. Jenkins says "It varies widely because of the PC that you have, and how many applications you have running at that point in time.

"And it certainly varies widely," Jenkins continues, "because as the Internet becomes more congested, let's say during peak business hours, the delay, the latency, the lost packets are going to go up, which means your quality is going to go down. If the Internet happens to be performing well at that instant in time, it might be as good as any telephone call."

Currently, most Internet phones can call out to both Internet and regular phones. But most will not allow incoming calls from a conventional telephone. This is yet another software limitation which, if overcome, could really speed the acceptance of Internet telephony.

Jenkins says that most companies are working on solving this shortcoming, and some companies may, in fact, offer this service by the time you're reading this article. But why does the problem exist in the first place? Jenkins says, "It's difficult for the terminating gateway, the terminating Internet phone, to know whether or not that user is on, and to translate from a phone number to an IP address, which is what they would have to do."

But the low cost may very well outweigh any reduction in quality and lack of dial-in capabilities. It suddenly becomes a lot cheaper to call those relatives on the other side of the country — or the planet. Or to call for a pizza delivery when you've only got one phone line, and you're using it to surf the net. Or to call similarly techno savvy friends on their Internet phones for free. Or to add a second phone line for a small business without having installation or monthly fees, beyond the actual usage charges.

Alexander Graham Bell must be smiling somewhere about what the Internet has done to his invention. All of a sudden, the entire planet is a local — or free — phone call away. Next to him (hey, it's my fantasy, so why not?), is probably Marshall McLuhan who would also, no doubt enjoy knowing that Internet telephony is making the prospect of his mid-1960s vision of "The Global Village" one step closer. **NV**

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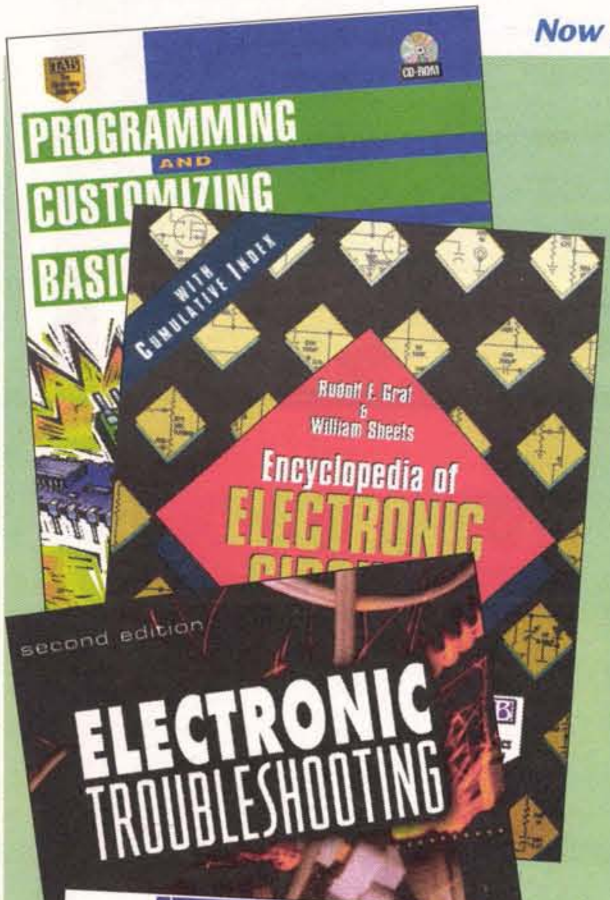

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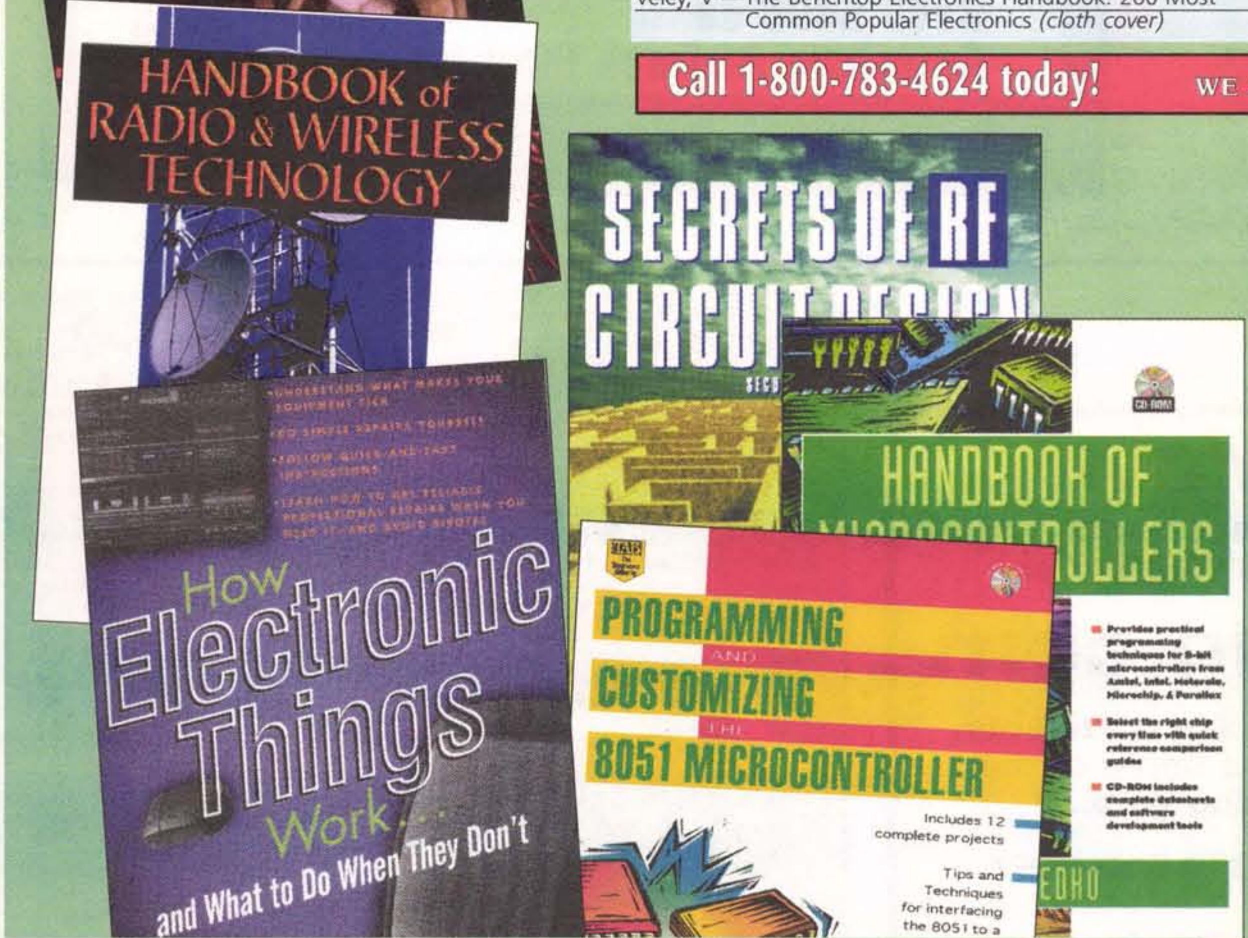

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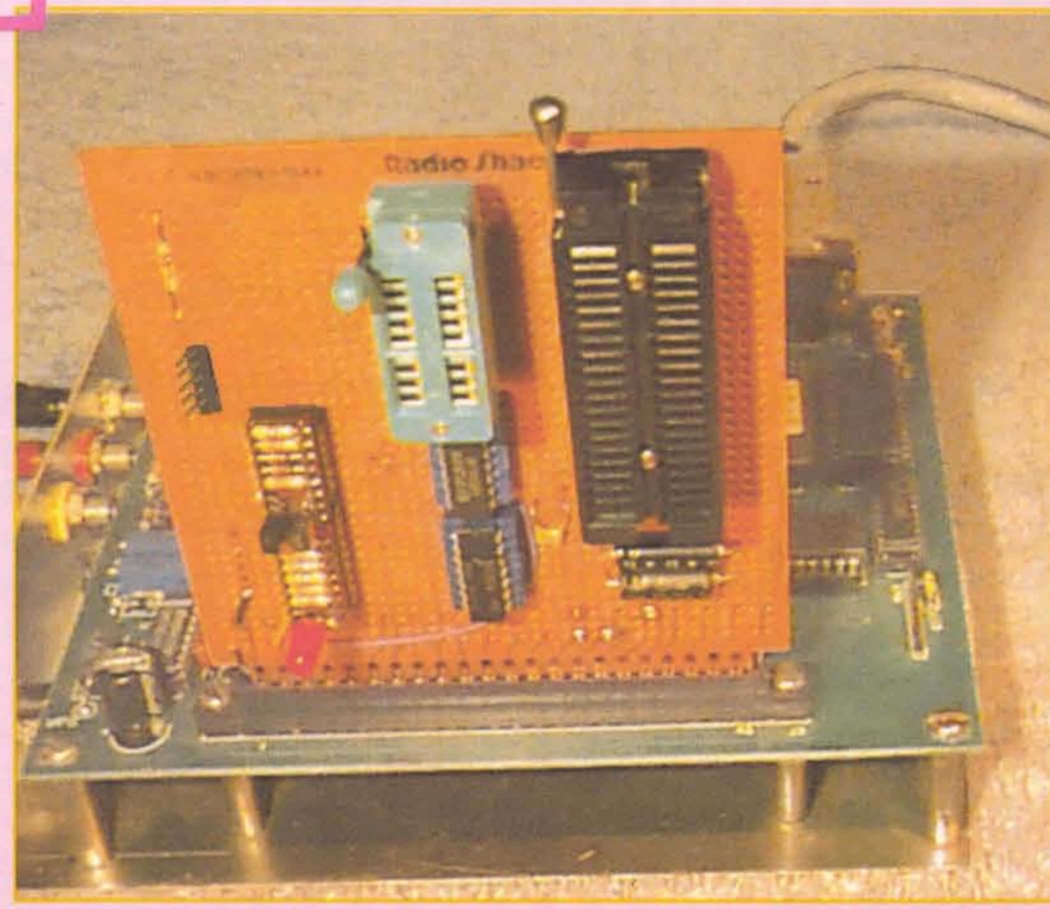
A PIC PROGRAMMING-MODULE FOR THE LP120 Part 2

by Brian Beard



INTRODUCTION

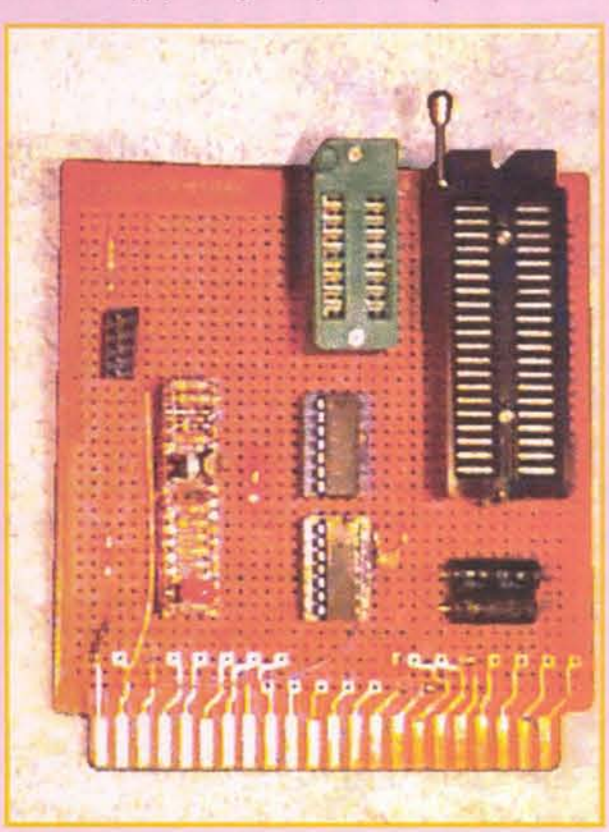
Last month, we talked about the LP120 general-purpose programmer. This month, we'll discuss a specific programming-module that allows the LP120 to program PIC microcontrollers. The PM-16C programming-module is designed for the mid-range PIC microcontrollers; these parts have 14-bit program memory and eight-bit data registers. Their part numbers all begin with PIC16C, such as PIC16C620 or PIC16C73. The mid-range parts are all programmed via a serial method.

PIC SERIAL PROGRAMMING

The serial programming specification is detailed in Microchip Technology's document DS30228. This document can be downloaded from the Microchip web site (http://www.microchip.com/).

Serial programming only requires five connections to the PIC being programmed. Two of these connections are obviously ground (Vss) and the supply voltage (Vdd). PICs are programmed with Vdd = five volts, however, to be fully compliant with the Microchip specification, the PIC must be verified at Vdd (min) and Vdd (max). Since the min and max supply voltages vary with the PIC model and clock option, Microchip recommends the verification voltages be user-selectable.

The third connection is the MCLR/Vpp pin of the microcontroller. During normal operation this is the Master CLeaR, or reset pin. To put the PIC in the program-mode, MCLR/Vpp must be raised from Vss to Vpp (13V) while RB6 and RB7 are held low. Vpp not only puts the PIC in the program-mode, but also supplies the voltage necessary to program the internal EPROM memory. The PIC's program-counter is set to 0000h upon entering the program-mode.



The fourth connection is the clock input (RB6). The programmer controls the clock signal and hence the rate of data transfer. Data transfer is synchronous, because it only occurs on clock signal edges, but aperiodic, because there is no specific clock rate. Command and data bits are latched into the PIC on the falling edge of the clock signal. The programmer reads data from the PIC on the falling edge of the clock signal.

The final connection is the data line (RB7). Commands are sent as six bits optionally followed by 16 bits of data as shown in Table 1. Since the mid-range PICs use 14-bit instructions, words are sent with leading and following zeros to fill out the 16 bit data field.

To program a particular location in the PIC's program memory, the programmer must know the current value of the PIC's program-counter. This is done by tracking the number of Increment Address commands (06h) sent since the PIC was placed in program-mode. Let's assume the PIC was just placed in program-mode so the program-counter is 0000h.

To program the instruction word at this address, the programmer must first send a Load Program Memory Data command (02h) followed by the appropriate instruction word. Next, the programmer sends the Begin Programming command (08h) followed, 100 microseconds later, by the End Programming command (0Eh).

This sequence will load an instruction word into the PIC, then burn it into the program memory at the current program counter address with a 100 microsecond Vpp pulse. Finally, the PIC's program-counter is advanced to 0001h by sending an Increment Address command (06h).

COMMAND, 6 bits		DATA, 16 bits
Load Configuration Word	00h	Configuration Word
Load Program Memory Data	02h	Instruction Word
Read Program Memory Data	04h	Instruction Word
Increment Address	06h	none
Begin Programming	08h	none
End Programming	0Eh	none

Table 1

HARDWARE

The PM-16C programming-module is the hardware interface between the LP120 and the PIC chip being programmed. Since all the mid-range PICs are programmed via the serial method, the electrical interface is common to all. This means the circuitry of the PM-16C can program any mid-range PIC. However, the physical interface isn't as simple. One simple DIP socket can't handle the variety of available device packages — we'll talk more about this later.

Theory of operation

Two requirements, specified by Microchip Technologies, drive the design of this interface.

First, the rise- and fall-times of Vpp must be less than eight microseconds. Since the Vpp switching power supply on the LP120 has

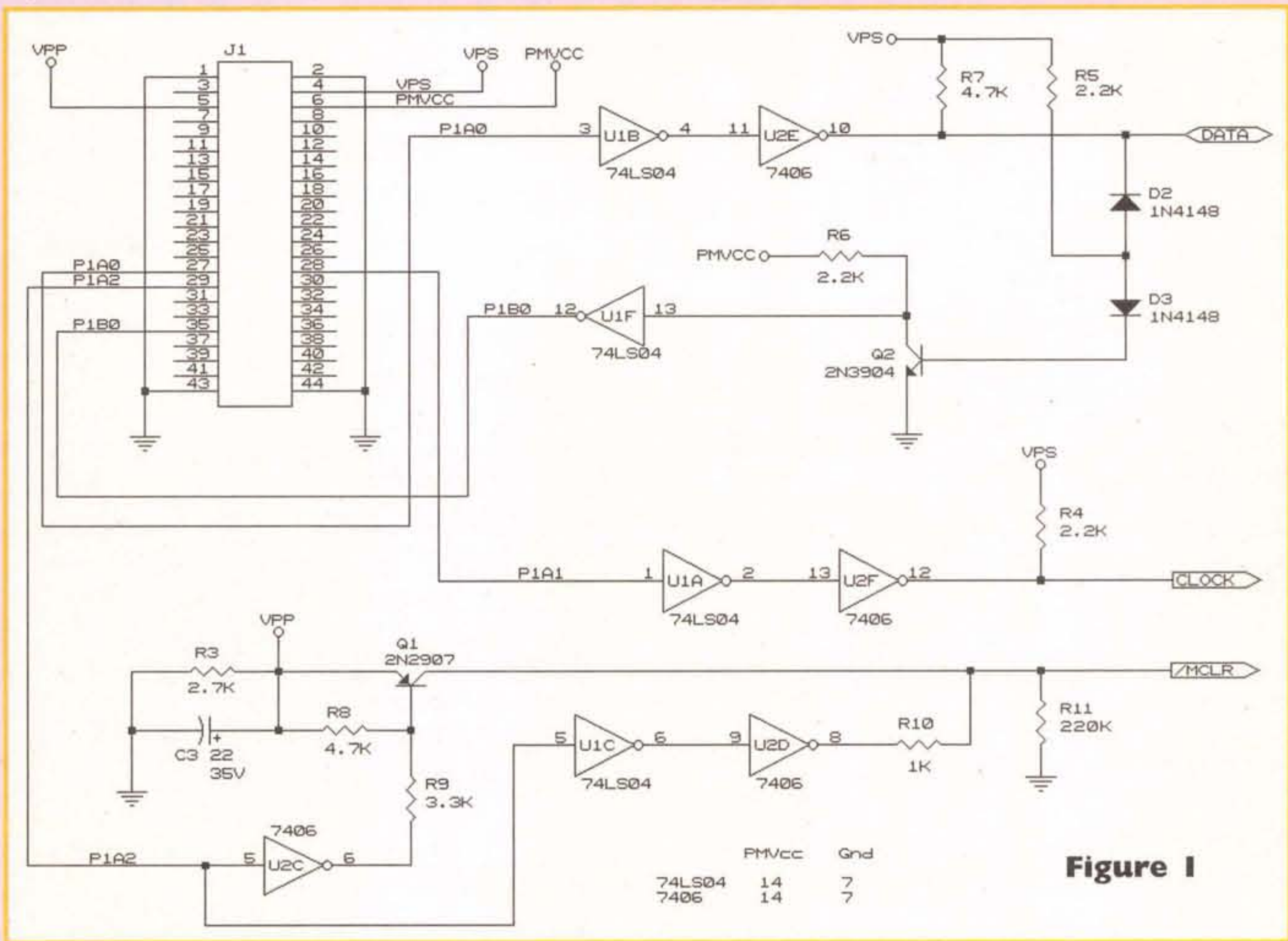


Figure 1

rise- and fall-times on the order of milliseconds, Vpp can't be connected directly to the MCLR/Vpp pin of the PIC. Instead, Vpp is applied to the PIC via the gating circuitry shown at the bottom of Figure 1. When P1A2 — the Vpp_gate signal — is low, Q1 is off and the output of U2D is low; this pulls the MCLR/Vpp pin low through R10. When P1A2 is high, the high-voltage open-collector output of U2D is floating and Q1 is on; this passes Vpp to the PIC.

Second, programmed PICs must be verified at Vdd (max) and Vdd (min) for full compliance with Microchip's programming specifications. As shown in Table 2, the voltage requirements for logic levels at the PIC — which vary directly with Vdd — are not compatible with the 5V TTL logic levels used by the LP120.

Therefore, bidirectional logic level translation is required between standard TTL logic levels and the PIC logic levels. VPS (V_programming _socket) provides the variable Vdd for the PIC while PMVCC (+5V) powers U1 and U2. Translation from TTL logic to PIC logic levels is simply done by using open-collector outputs with pull-up resistors to VPS. U2F translates the Clock signal and U2E translates Data going from the LP120 to the PIC.

Data going from the PIC to the LP120 is translated from PIC logic levels to TTL logic by D2, D3, and Q2. While the serial data pin on the PIC is bidirectional, the LP120 uses separate data_in (P1B0) and data_out (P1A0) lines. When the PIC is sending data, the LP120 sets P1A0 high so the output of U2E floats; this allows the PIC to control the common data node.

Programming sockets

The mid-range PICs are available in a variety of sizes: 18-, 28-, and 40-pin DIPs. The schematic in Figure 2 shows two sockets that can accommodate all three DIP sizes. Eighteen pin DIPs are programmed in the 18-pin socket (U4), while 28- and 40-pin DIPs are both programmed in the 40-pin socket (U3). Twenty-eight pin PICs are inserted such that pin 1 of the chip is in pin 1 of the 40-pin socket. Programming sockets should always be of the Zero-Insertion-Force (ZIF) or burn-in type.

Also shown in Figure 2 is a red LED powered by PMVCC. This LED is used to indicate that power is applied to the PM-16C. PIC chips may be inserted or removed from their programming socket only when this LED is off.

In addition to DIPS, some of the mid-range PICs are available in other package types, such as SOIC, QFP, and PLCC. The first thing you need to program a PIC in one of these packages is a compatible socket. Next, the five required serial programming lines need to be connected to the correct pins on the socket.

The easiest way to do this is to connect the socket to header (J2) shown in Figure 3. This can be done by soldering wires to the pins on the bottom of the socket then running the wires to a header that connects to J2 on the PM-16C. Figure 4 shows an example of how a PLCC socket might be connected.

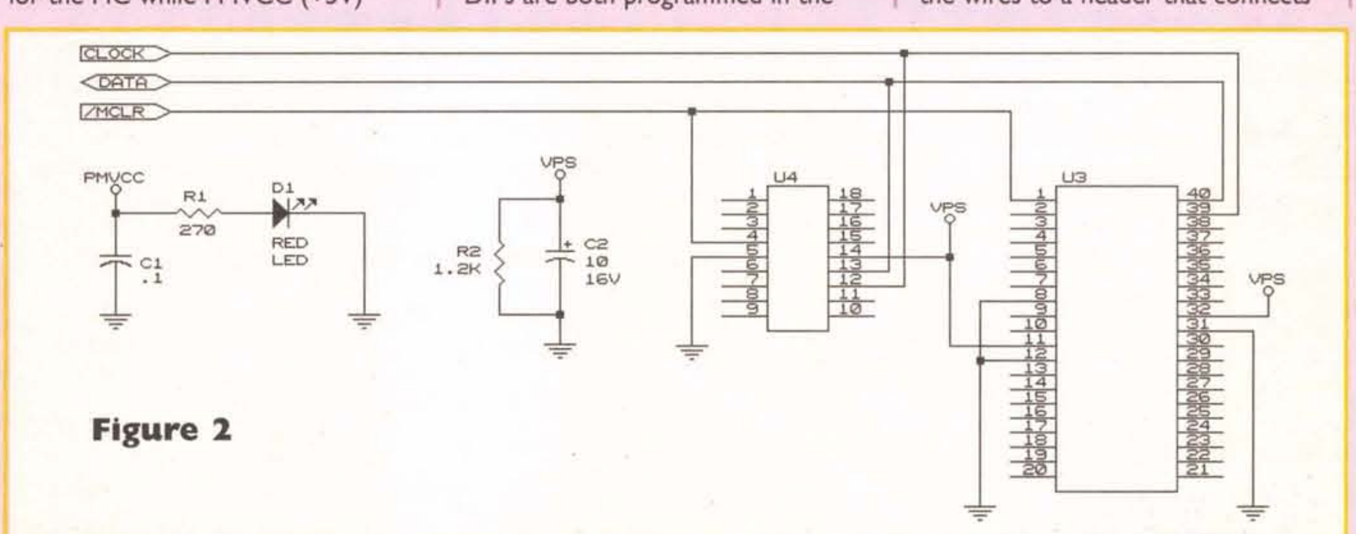


Figure 2

Construction

The programming-module may be constructed on any prototype board compatible with the LP120 programming connector, J1 in Figure 1. J1 is a 44-contact edge connector (22 x 2) on 0.156 inch spacing. The PM-16C shown in the picture was built using wire-wrap on a prototype board ordered from the RadioShack catalog (RSU10524486; $3.79).

Note that odd numbered contacts are on the component side, while even numbered contacts are on the wire-wrap side. A printed circuit board is being designed and will be available for those who don't want to "roll their own."

One caution on purchasing the 40-pin ZIF socket for your PM-16C. Some 28-pin PICs are available as skinny DIPs. On skinny DIPs, the rows of pins are 0.3 inches apart rather than the 0.6 inch spacing normally found on 28-pin DIPs. Forty pin ZIF sockets made by Aries can hold skinny or normal parts; those made by 3M can only hold normal parts.

SOFTWARE

Device driver programs

Putting the configuration data for all the current mid-range PICs into one device driver is possible, but Microchip keeps announcing new models, and it wouldn't be long before the device driver was larger than the available memory. Therefore, the PICs were split among three device drivers based on their part number. See Table 3.

The device drivers were written in 6801/3 assembly language and assembled with the freeware cross-assembler mentioned in last month's article. The starting point for all LP120 device drivers is the Device Driver Header file shown in the sidebar. This file contains comments providing information on the LP120 memory map, port usage, and reserved memory. The equates provide standardized names for the 6803 ports and register, the PIAs, and the Toolbox routines.

The device driver program is transferred from the host to the LP120 using the [U]pload option in the LP120 main menu. As with all LP120 uploads, this is an ASCII file transfer. The device driver should execute automatically following its upload. However, if the display returns to the LP120 main menu, select the [J]ump option.

Driver option menu

The PIC device driver will display an option menu similar to the one shown below.

PIC16C6XX MENU
Current processor = PIC16C61
[1] Change processor type
[2] Change Vdd(min)

```
[3] Change Vdd(max)
[B]lank/erased check
[U]pload HEX file to RAM
[I]D locations data
[W] Configuration word
[E]dit/display RAM buffer
[P]rogram part from RAM
[V]erify part with RAM
[C]ompute RAM checksum
[R]ead part into RAM
[D]ownload RAM
[Q]uit to LP120 menu
?
```

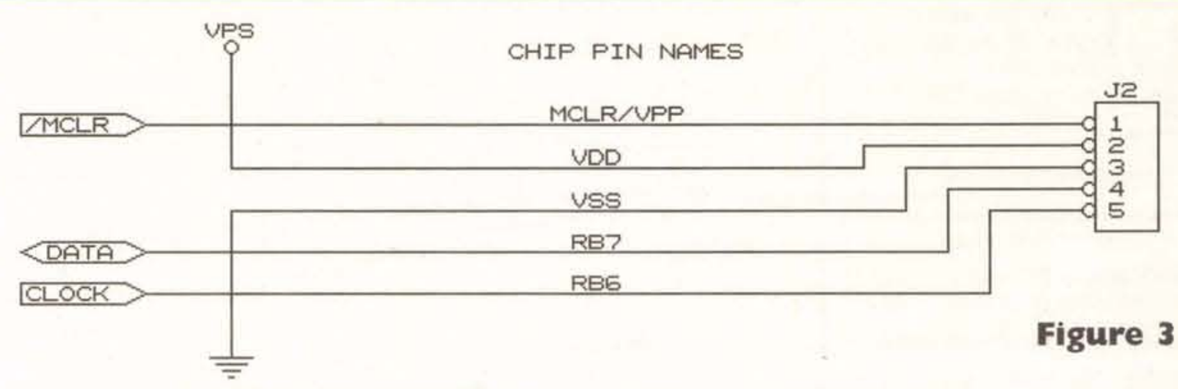


Figure 3

The LP120 will then loop waiting for an input. Options are selected by typing the character in brackets. Invalid inputs cause the menu screen to be redisplayed. All inputs are case sensitive.

[1] Change processor type

When the PIC driver program begins, it will automatically branch to this option. Choose the desired processor by completing the part number at the prompt. Incorrect entries will cause the prompt to be displayed again. After a valid entry, the driver menu will be displayed with the selected processor shown as the "current processor." The current processor may be changed at any time.

[2] Change Vdd (min) and [3] Change Vdd (max)

These options allow the operator to change the minimum and maximum supply voltages used to verify the current part. When a part is selected via option 1, Vdd (min) and Vdd (max) are set to the default values of 3.00 and 5.49 volts, respectively. The usable Vdd (min) and Vdd (max) vary not only with the type of part, but also with the type of oscillator selected and frequency of operation. Therefore, verification should be done over the supply voltage range determined by the specific application.

[B]lank/erased check

This option will read the program and configuration memory from the part in the programming socket. If any word differs from the erased value (3FFFh), an error will be reported.

[U]pload HEX file to RAM

This option will upload an Intel

```
* FILE HEADER FOR LP120 DRIVER PROGRAMS
* COPYRIGHT 1990-1999 BY LUCID TECHNOLOGIES
* WRITTEN BY BRIAN BEARD, OWNER AND PRESIDENT
* ALL RIGHTS RESERVED
*
*6801/6803/6303R MPUs MAY ALL BE USED IN MODE 2.
*PORTS 3 AND 4 COMPRISE A MULTIPLEXED ADDRESS AND DATA BUS.
*CRYSTAL = 3.6864 MHZ, E = 921600 HZ, 1.085 uSEC PER CYCLE.
*EXECUTABLE PROGRAMS MUST LOAD TO RAM BETWEEN $0020 AND THE
* THE LP120 RESERVED RAM (RESRAM). IF OTHER THAN $0100, THE
* START ADDRESS MUST BE CONTAINED IN THE S9 RECORD. THIS MAY
* REQUIRE EDITTING THE OUTPUT OF THE ASSEMBLER.
*
*MEMORY MAP (MODE 2) ----------------------------------------
* $0000-$001F     MPU REGISTERS
* $0020-$007F     EXTERNAL RAM, 62256
* $0080-$00FF     INTERNAL RAM, 6803/6303R
* $0100-$7FFF     EXTERNAL RAM, 62256
* $8000-$9FFF     XTERNAL RAM, 6264
* $A000-$A3FF     UNUSED
* $A400-$A7FF     PIA ZERO
* $A800-$ABFF     PIA ONE
* $AC00-$BFFF     UNUSED
* $C000-$FFFF     EXTERNAL EPROM, 27128
*
*MPU PORT AND I/O USAGE ------------------------------------
*PORT 1
* P10  MAX522 CHIP SELECT, ACTIVE LOW    OUTPUT     PULLUP
* P11  MAX522 SERIAL CLOCK               OUTPUT     PULLUP
* P12  MAX522 SERIAL DATA                OUTPUT     PULLUP
* P13  PMVcc SWITCH, ACTIVE LOW          OUTPUT     PULLUP
* P14  PMVfw SWITCH, ACTIVE LOW          OUTPUT     PULLUP
* P15  UNUSED                                       PULLUP
* P16  UNUSED                                       PULLUP
* P17  UNUSED                                       PULLUP
*
*PORT 2
* P20  MODE SEL                          INPUT      PULLUP
* P21  MODE SEL                          INPUT      PULLUP
* P22  MODE SEL/EXTERNAL BAUD CLOCK      INPUT
* P23  SCI RX DATA                       INPUT
* P24  SCI TX DATA                       OUTPUT
*
*INTERRUPTS
* NMI  UNUSED                            INPUT      PULLUP
* IRQ  PIA-0                             INPUT      PULLUP
*
*MPU EQUATES -----------------------------------------------
P1DDR    EQU   $00    *PORT 1 DATA DIRECTION REGISTER
P2DDR    EQU   $01    *PORT 2 DATA DIRECTION REGISTER
P1DAT    EQU   $02    *PORT 1 DATA REGISTER
P2DAT    EQU   $03    *PORT 2 DATA REGISTER
TCSR     EQU   $08    *TIMER CONTROL AND STATUS REGISTER
CNTR     EQU   $09    *2-BYTE COUNTER VALUE, $09=MSB
OUTCR1   EQU   $0B    *2-BYTE OUTPUT COMPARE REGISTER
INCAP    EQU   $0D    2-BYTE INPUT CAPTURE REGISTER
RMCR     EQU   $10    *RATE AND MODE CONTROL REGISTER
TRCSR    EQU   $11    *TX/RX CONTROL AND STATUS REGISTER
RXDAT    EQU   $12    *RECEIVE DATA REGISTER
TXDAT    EQU   $13    *TRANSMIT DATA REGISTER
*
*PIA (6821) ADDRESS EQUATES ---------------------------------
* A-SIDE PORTS HAVE INTERNAL PULLUP RESISTORS.
P0A      EQU   $A400  *PIA-0 DDR OR DATA FOR A-SIDE
P0ACR    EQU   $A401  *PIA-0 CONTROL REGISTER FOR A-SIDE
P0B      EQU   $A402
P0BCR    EQU   $A403
PIA      EQU   $A800
PIACR    EQU   $A801
PIB      EQU   $A802
PIBCR    EQU   $A803
*
*MISC. EQUATES ---------------------------------------------
TRUE     EQU   $FF
FALSE    EQU   $00
*
*ASCII EQUATES ---------------------------------------------
BELL     EQU   $07    *BEEP
BS       EQU   $08    *BACK SPACE
LF       EQU   $0A    *LINE FEED
CR       EQU   $0D    *CARRIAGE RETURN
ESC      EQU   $1B    *ESCAPE
SPACE    EQU   $20    *SPACE CHARACTER
*
*TOOLBOX EQUATES -------------------------------------------
RESET    EQU   $C000  *JMP HERE TO TERMINATE DRIVER
DLY_B    EQU   $FF6C  *JSR
GETVPP   EQU   $FF70  *JSR
GETVPS   EQU   $FF74  *JSR
DWNMOT   EQU   $FF78  *JSR
DWNHEX   EQU   $FF7C  *JSR
RX4HEX   EQU   $FF80  *JSR
RX3HEX   EQU   $FF84  *JSR
RX2HEX   EQU   $FF88  *JSR
RX1HEX   EQU   $FF8C  *JSR
TX2ASC   EQU   $FF90  *JSR
TX4ASC   EQU   $FF94  *JSR
EXITMM   EQU   $FF98  *JMP HERE FOR LP120 MAIN MENU
BINBCD   EQU   $FF9C  *JSR
UPMOT    EQU   $FFA0  *JSR
ADRMOT   EQU   $FFA4  *JSR
UPHEX    EQU   $FFA8  *JSR
ADRHEX   EQU   $FFAC  *JSR
VPPSET   EQU   $FFB0  *JSR
VPP_NC   EQU   $FFB4  *JSR
VPSSET   EQU   $FFB8  *JSR
VPS_NC   EQU   $FFBC  *JSR
PWROFF   EQU   $FFC0  *JSR
PIAOFF   EQU   $FFC4  *JSR
PIADAT   EQU   $FFC8  *JSR
PIADDR   EQU   $FFCC  *JSR
ASCHEX   EQU   $FFD0  *JSR
HEXASC   EQU   $FFD4  *JSR
MSGOUT   EQU   $FFD8  *JSR
SCITX    EQU   $FFDC  *JSR
SCIRX    EQU   $FFE0  *JSR
RXECHO   EQU   $FFE4  *JSR
RXWAIT   EQU   $FFE8  *JSR
DLY_A    EQU   $FFEC  *JSR - APPROX (50 uSEC)*X
*
*RESTRICTED AREA -------------------------------------------
RESRAM   EQU   $9C00   *START OF LP120 RESERVED RAM,
ORG      RESRAM        * FOR SYSTEM VARIABLES, STACK, ETC.
RMB      $03FF  *  $9C00-$9FFF = 1K
*
*====================== VARIABLE STORAGE ======================
         ORG   $0020

*
*====================== EXECUTABLE CODE =======================
         ORG   $0100

*
```

Hex Format file (*.HEX). Microchip often refers to this as the eight-bit merged (INHX8M) format and is the default output for MPLINK and MPASM. Each line in this file is called a record. Uploads are done with the ASCII file transfer facility of your communications program.

The driver sets the entire RAM buffer to the erased state at initialization, but not prior to an upload. The upload will overwrite data already in RAM. As each record is received, it is checked for accuracy and stored at the appropriate location in the buffer. When a valid termination record is found, the transfer is complete.

An error of any sort during the upload process terminates the upload. All records received before the error was encountered are stored in the buffer. Displaying the contents of the buffer can show you where the error occurred.

Following a successful upload, a warning message will be displayed if configuration word information was not present in the hex file. The ID locations in the buffer will be written as 3F8X, where X is the least significant nibble specified in the hex file; this is the pattern recommended by Microchip.

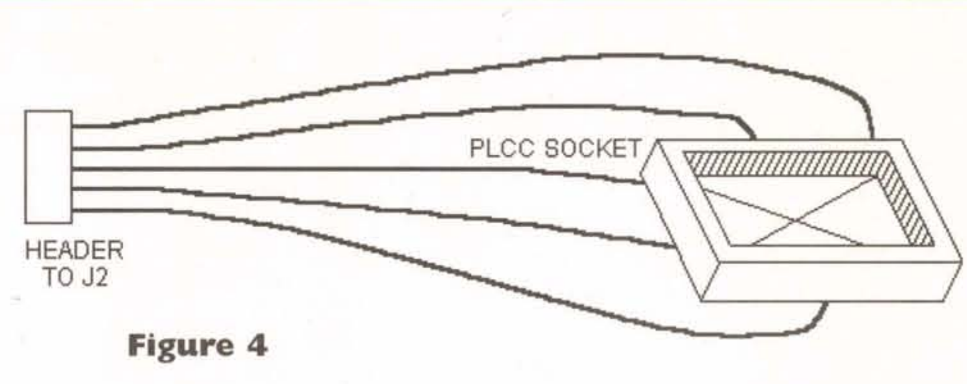


Figure 4

[I]D locations data

This option will display the hex characters comprising the four least significant bits of the four ID locations mapped from 2000 to 2003. Microchip recommends that only the four least significant bits in each location be used.

[W] Configuration word

The configuration word option will bring up the submenu shown below. The current state of the configuration word (location 2007) is reflected in this submenu. Details of these options are explained below.

[O]scillator 00:LP
[W]atchdog timer ON
[P]ower up timer ON
[B]rown out detect ON
[R]eset voltage 4.5V
[C]ode protect OFF
[Q]uit

[Oscillator] This option will change the state of the oscillator bits to the next of the four possible states. The value of the two oscillator bits and the corresponding oscillator type are both shown.

[Watchdog timer] This option will toggle the state of the watchdog timer bit.

[Power up timer] This option will toggle the state of the power up timer bit.

[Brown out detect] This selection will only be displayed if the current processor has this feature available. This option will toggle the state of the brown out detection bit.

[Reset voltage] This selection will only be displayed if the current processor has this feature. This option will change the state of the brown-out reset voltage bits to the next of the four possible values.

[Code protect] This option will toggle the state of the code protection bits from OFF to ALL and back. Partial code protection is not implemented by this driver. For those parts that offer partial code protection, it can be obtained by manually changing the configuration word using the Edit option.

NOTE: After manually editing the code protect bits for partial protection, the state of code protection shown in the Configuration Word menu will be incorrect. Selecting the Code Protect option, after manually editing the configuration word, will force the code protect bits back to all or none!

[Quit] This option will return you to the previous menu level.

[E]dit/display RAM buffer

The edit/display RAM option will bring up the submenu shown here. Details of these options are explained below.

[F]ill RAM
[D]isplay RAM
[E]dit RAM
[Q]uit

[Fill RAM] This option will fill the RAM buffer with any four-digit hex value you specify. This option can be used to set the RAM buffer to the erased value (3FFF).

[Display RAM] This option will display the contents of the buffer RAM in hexadecimal and ASCII formats. Each line consists of eight words. The starting address of each line is shown at the left, followed by eight hex numbers, and the eight ASCII characters that represent the least significant byte of each word. The ASCII data is filtered to remove control characters and extended values that some terminals will not display. After the display reaches the top of the current part's program memory, it automatically jumps to configuration memory. One line of configuration memory (2000-2007) is displayed. Typing a "space" character stops the display until any other character is typed. Typing an "escape" character will terminate the display.

[Edit RAM] With this option you can change the value of any word in the RAM buffer. Each line displays the current address and the data stored there. Typing a "space" or "enter" will advance the display to the next line. To modify the data at an address, type in the new hex value; the new value will be placed in the buffer and the current line will be redisplayed. At the top of program memory, the address automatically steps to configuration memory. In configuration memory, only the ID locations and the configuration word are shown since these are the only writable addresses.

[Quit] This option will return you to the previous menu level.

[P]rogram part from RAM

After selecting this program option, you will be given the chance to return to the main menu, just in case you made a mistake. The part is programmed with Vdd=5V; a programming error will be reported if any location fails to verify at this voltage. Since Microchip has separate programming algorithms for program and configuration memory, their progress is reported separately.

The programming algorithm specified in DS30228 checks that the part is erased, programs the part, then verifies the part. Lucid's drivers separate this algorithm into three parts. By executing the Blank, Program, and Verify options (in that order), the complete programming algorithm specified by Microchip is followed.

[V]erify part with RAM

This option will do a word-by-word comparison between the data in RAM and the PIC in the programming socket. It will be done three times in rapid succession with Vdd=Vdd(min), Vdd=5V, and Vdd=Vdd(max). If any pair of words does not agree, a failure will be reported.

[C]ompute RAM checksum

Before a checksum can be computed, the buffer must be loaded by either Reading a part into RAM, or a HEX file Upload. DS30228 specifies a different checksum formula for each part and for each level of code protection. Lucid's drivers use a single

Table 2

	PIC Vdd = 2V	PIC Vdd = 6V	LP120 TTL
Logic 0	<0.4V	<1.2V	<0.8V
Logic 1	>1.6V	>4.8V	>2.4V

Table 3

Device Driver	Part Numbers Programmed
16C6X	Parts beginning with PIC16C6; such as PIC16C61, PIC16C620, etc.
16C7X	Parts beginning with PIC16C7; such as PIC16C71, PIC16C710, etc.
16C9X	Parts beginning with PIC16C9; such as PIC16C923, etc.

algorithm to compute all checksums. A 16-bit checksum is computed as the sum of all the words in the current part's program memory plus the configuration word AND'ed with the mask specified in DS30228 for code protection off. After the checksum is calculated the following prompt will appear:

```
Checksum = 4A73
Use checksum as ID? (Y/N)
```

Typing an N will leave the ID locations unchanged, typing a Y will place the four ASCII characters of the checksum in the LSB of the four ID locations. For the example above, this would be:

```
2000 = 4, 2001 = A, 2002 = 7,
2003 = 3
```

Note that since the ID locations are not used in the checksum calculation, changing them will not affect the checksum.

[R]ead part into RAM

The read part into RAM option copies the code from a previously programmed part into the RAM buffer. The data in RAM can then be used to program copies of the original or downloaded for storage as a file. This option will not work if the part being read has code protection active.

[D]ownload RAM

The download option will send the contents of the RAM buffer to the host as a HEX file. Before starting the download, you must enable a "log" or "ASCII capture" file from your host's communication program. Typing an "escape" character will abort the download and return the main menu. Once begun, the download cannot be aborted. Records for which all the data is 3FFF will be omitted since this is the erased state. At the end of the download the following message will appear.

```
Download complete!
```

Remember to close the log file at this time. The file will require editing to remove text lines that don't belong in a HEX file.

[Q]uit to LP120 menu

This option will exit the driver and return to the LP120 opening menu. This will overwrite the driver program so don't quit until you are finished with the currently loaded driver. **NV**

PM-16C Parts List

Quan.	Reference	Part
Semiconductors		
1	D1	Red LED, T-1+3/4
2	2,D3	1N4148, switching diode
1	Q1	2N2907, PNP transistor
1	Q2	2N3904, NPN transistor
1	U1	74LS04, hex inverter
1	U2	406, hex inverter with open-collector high-voltage outputs
Capacitors		
1	C1	0.1u, 50V
1	C2	10u, 16V
1	C3	22u, 35V
Resistors (0.25W, 5%)		
1	R1	270 ohm (red-violet-brown-gold)
1	R2	1.2k (brown-red-red-gold)
1	R3	2.7k (red-violet-red-gold)
3	R4,R5,R6	2.2k (red-red-red-gold)
2	R7,R8	4.7k (yellow-violet-red-gold)
1	R9	3.3k (orange-orange-red-gold)
1	R10	1k (brown-black-red-gold)
1	R11	220k (red-red-yellow-gold)
Sockets		
2	U1,U2	14-pin
1	U3	40-pin Zero Insertion Force (ZIF), Aries-type preferred
1	U4	18-pin ZIF
Miscellaneous		
1	J2	Five-pin header

The LP120 and PM-16C are available from Lucid Technologies, see the web site at www.cs.net/lucid/. Send questions or comments to lucid@cs.net.

PORTABLE HIGH-FREQUENCY SYSTEM UNDER TEST

by Gordon West

The SGC worked all the way down to 10 volts on the battery pack.

Transmitting and receiving signals off of the ionosphere takes place on the high-frequency band, 3 MHz to 30 MHz. Communication's range may extend 30 miles out for continuous groundwave, yet up to 10,000 miles away, skywave.

Long-range skywave communications do not necessarily need 100 watts output, the typical power levels of most marine SSB long-range transceivers, ham sets, and high-frequency, long-range aviation radios. What 100 watts *will* do is overcome the other station's noise level in case they're sitting on a boat with refrigeration running, or sitting at home with computer hash blanking out the weak signals.

Many marine sideband operators including some maritime mobile ham stations may not realize they are missing the weak signals because of an elevated noise floor onboard. One boat owner was surprised everything that she could hear on the 20-meter band after I had switched off refrigeration, florescent lights, a battery charger, and finally a UV tube in the water purification system. The S-meter went from S-9 down to S-3, and out of nowhere hundreds of stations could now be heard loud and clear above the normal atmospheric static level.

Aviation and marine high-frequency government shore stations usually work off of antenna systems in guaranteed quiet zones. These huge antennas are standing by from incoming traffic from ships and aircraft thousands of miles away. The noise floor at these remote antenna sites is so low that you can actually hear lightning strikes thousands of miles away, confirmed by hearing the strike over the relatively quiet high-frequency bands and seeing it show up on real-time lightning tracking web sites, as monitored by satellites.

Amateur operators may try to outdo themselves on talking the furthest with the least amount of power. Hams call this QRP — operating at power levels usually less than a watt. Many ham QRP operators will show you their QSL card collection showing contacts with fellow QRPers 8,000 to 10,000 miles away with both stations running power levels less than 1/10th of a watt. Of course, big directional antennas make up the difference!

SGC, Inc.
ATTN: Pierre Goral
Bellevue, WA
1-800-259-7331

One leading USA manufacturer of military, marine, aviation, and amateur radio equipment recognized the need for a relatively small and portable high-frequency transceiver, battery D-cell capable, covering all worldwide frequencies from 1.8 MHz through 30 MHz. The company is SGC, Inc. (http://www.sgcworld.com), located in Bellevue, WA.

This unique transceiver is the Model SGC-2020, along with a snap-on PortaPack which may hold 10 "D" size alkaline batteries, or 10 "D" size nickel cadmium (NiCad) cells.

During our many reviews of this package, including numerous tests in remote Alaska during the Anchorage and Fairbanks hamfests, the battery pack with alkaline cells gave us a full day of listening and a little talking out in Alaska back country to stations down in the lower 48 and further.

The SGC-2020 transceiver is factory preset for 20 watts of peak envelope power output, front panel adjustable down to one watt PEP to conserve battery power, or up to 40 watts if you want to do some serious hamming using upper or lower sideband running off of the vehicle's 12-volt system or a larger 12-volt battery pack. We could run up to 40 watts PEP off of the "D" alkalines, but we only stayed on the air for about an hour doing half-listening and half-talking on ham frequencies.

The 2020 has 20 channels of factory preprogrammed memory, preset to each of the nine worldwide ham bands. This gets you to each band quickly without having to sit there and spin the knob from 1.8 MHz to 29.7 MHz. Each memory position may be selected for a specific amount of transmitter output power, a specific amount of bandwidth filtering, mode, split VFO, and any memory channel may be rewritten to accommodate the specific use of the equipment in the field.

During our tests of the SGC-2020, both down here in the lower 48, as well as up in Alaska, everyone liked the crisp, clear, razor-sharp receiver with the adjustable filter control. The bandwidth is adjustable from 2.7 kHz for SSB down to 100 Hz when using the equipment with a laptop on PSK-31, the ultra-narrow new digital mode. Sub-menu items are looked up in the extensive instruction manual, and are accessed by pressing the CMD button and one of the other buttons simultaneously, but momentarily.

For instance, on 10 meters in Alaska, signals were so strong that we wanted to reduce the power outputs on memory channel 20, dedicated to 10-meter CW, down to one watt. We would press CMD and NB simultaneously, release, and then turn the big tuning knob down to one. We would enter this setting in the 10-meter memory 20

The SGC 2020 portable, operating on fence post in Alaska.

channel by pressing Fast and Memory together.

It took us a little time to completely understand all that the CMD button would do for us, but the old ham adage of "when all else fails, read the instruction manual" holds true here — especially with a little radio with plenty of big radio button features.

For CW, the electronic keyer is built in and fully adjustable. You need the 3.5 mm stereo phone plug on the end of your keyer paddles, so be sure to get the adaptor at RadioShack before you leave on your radio outing. The built-in keyer is similar to the Curtis-type, B-format, iambic keyer.

There is also a second key jack on the front of the panel below the electronic keyer jack — this is a 3.5 mm monophone jack for those of you that wish to operate the 2020 full break-in with a straight key. A side tone of 650 Hz is also activated with both keys. And, if you forget the telegraph key, you can even key CW via the mike!

On SSB, the signal from the microphone is amplified by a Vogad circuit, and there is speech processing that is preset to give a very full sound to our voice. I was delighted to see the ALC circuit turned fairly well down, giving me good peaks on transmit. Many of the other 100-watt worldwide ham sets have the ALC set so high that average talk power looks almost identical to what we were seeing on the Bird with the SGC-2020 in the maximum power setting. SGC cautions not to operate at maximum power settings for extended CW contacts, or data modes. SGC claims that the 2020 supports all data modes, and by electronic keying the equipment is certainly fast enough to handle AMTOR and PACTOR with the right multimode controller.

ANTENNA CONSIDERATIONS

Another thing I liked about the SGC-2020 was no apparent VSWR shutdown circuitry. This means — in an emergency aboard a boat or in the air or on land — you can hook up to just about anything and the SGC-2020 will jam the signal into whatever conductor and ground system you have. Of course, nothing beats the unity gain of the proven dipole, and anyone can build a dipole with RG-174 for under $5.00 per band. We ran the relatively inexpensive Alpha Delta five-band dipole and worked all over the world on 15, 17, and 20 meters. The Alpha Delta dipole has individual halfwave elements separated by a spacer, and 80 works off of 40 with a loading coil which doubles as the 40-meter trap.

But this transceiver will be popular among emergency agencies like FEMA, Red Cross, Salvation Army, and United Nations stations who may have frequency authorizations outside of normal ham band limits. The SGC-2020 goes anywhere after a simple unlock procedure.

Wishing to keep everything precisely portable, we added the SGC-237 automatic antenna coupler which is an active long wire antenna tuner. The tuner comes with a nine-foot, four-conductor cable with coax on the inside. The four-conductor cable is for powering the active antenna coupler, and for locking it for certain mobile applications, and an optional light-emitting diode tuned indicator. The coupler is completely weatherproof, so it may be mounted out in the open.

In one remote application, we grounded the coupler with copper foil to sea water. Our radiating long wire was about 60 feet long, and was shot over a nearby tree to give it some elevation. A simple whistle in the microphone — giving proper FCC identification — is all that is needed to put the SGC-237 in the active tune mode on modulation.

The coupler monitors forward power and reflected power, while tuning an array consisting of seven capacitors in shunt on the input arm of the network, eight inductors in the series arm, and four more capacitors in shunt on the output arm, all arranged in binary increments.

Relays are provided in conjunction with each lumped constant and allow removal or entry as necessary. This leads to a network having 128 values of input shunt C, 16 values of output shunt C, and up to 256 values of series L with the 19 little relays zipping into a match with full power out, minimum power reflected.

Once the tuner achieves the best match on almost any type of ground to any type of radiating wire, the data is transferred into the CPU for a return-again preset condition if you go off to another band, and then come back to this band. The tuning algorithm for each band is permanently set in its EEPROM which is addressed by the applied RF frequency. When we would go back to a band we had already tuned up on, the right relays are all dropped in simultaneously, and the tuner keeps the relays in place until it detects the

need to retune.

Down on 75 and 160 meters, the tuner would retune if we went off frequency by more than 30 or 40 kHz. This is normal, and this let us know that everything was working fine.

We monitored the performance of the tuner with an RF thermo-coupler ammeter in series with the antenna output. There was no question we were putting out plenty of power, looking at the RF ammeter, and listening to the number of stations coming back to our calls.

For mobile operation, we ran the 2020 directly into pre-tuned whips. We gave the MFJ whips a good workout, and we hear they are made by Anntron, and they really worked well on the specific band for which each whip was cut. I also brought along the trusty Outbacker, and you tap into each band that you want to operate.

If you want to run the SGC-237 coupler into the SGC-303 high-frequency whip, you now have a mobile installation where you won't even need to get out of the car to change bands. Just squawk on the mike, and presto, that big whip on the top of the vehicle instantly takes the power output from the 2020 and gets it up to the ionosphere.

There indeed are other manufacturers of truly QRP transceivers with plenty of features, but they don't do a battery pack like the SGC-2020 nor can they increase power up to 20 watts to 40 watts out. And yes, there are twice as expensive ICOM and Yaesu transceivers that offer 100 watts output, plus six meters, two meters, and 440 MHz, too, in a transceiver body actually smaller than the SGC-2020. But these rigs don't have the snap-on battery pack capabilities either. These 100-watt rigs are also much more sensitive to VSWR anomalies — and unless you give them the perfect antenna, power output drops back to truly QRP levels. But the SGC-2020 continues to crank out 20 watts to 40 watts under varying antenna conditions, and with the strap-on battery pack, it makes this rig an ideal choice for those of us in the emergency radio response field who need a set that can operate as a compact portable, yet provide medium-range contacts on 40 meters and long-range contacts on 20 meters and shorter wavelengths.

SGC, Inc., also makes FCC-certified marine, land, and aviation long-range radio equipment for specific emergency agency applications. As a member of the United States Coast Guard Auxiliary, plus other emergency agencies on high frequency, these groups may not require the more stringent FCC certification of equipment operating just above and below the ham bands for which the SGC-2020 is designed. This makes the 2020, along with its snap-on battery pack, along with the SGC-237 antenna coupler, something to look into when next setting up your long-range radio response package. **NV**

PORTABLE HIGH-FREQUENCY SYSTEM UNDER TEST

Continued from page 42

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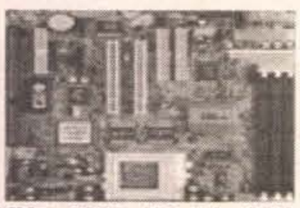

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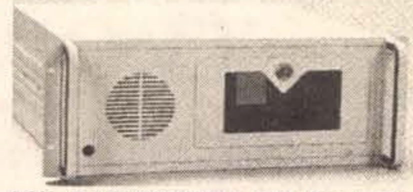

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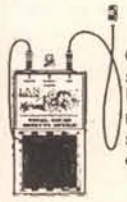
Top 10 Favorite Gateway Gizmos and Gadgets



VOICE CHANGER KIT $49.50
Change your voice with this really cool kit! Using DSP (Digital Signal Processing), you can make a man sound like a woman, make a woman sound like a man, create scary monster sounds, and have lots of fun. Use the special echo and vibrato modes for additional special effects. Kit features clip-on electret mic, removable speaker with case, sound effects selector switch, adjustable volume control, up/down pitch shifts, and step-by-step instructions. 3.5mm jacks for the microphone and speaker make it easy to connect to other audio equipment. Requires 4 AA batteries (not included.)

Infrared Non-Contact Laser Thermometer *introductory price* **$149.95**
This is such a cool thing, you gotta get one! No more climbing ladders or going down manholes trying to find temperatures. Are the rafters hot? How hot is that car? Point this little gizmo at almost anything and it will give you the temperature! Uses a laser sighting to help confirm target, and features an easy to read large LCD. Fahrenheit or Celsius selectable. Features a 0.95 emissivity, 8:1 distance to spot ratio, 0.1 resolution, and a temperature range of 14 to 950 degrees Fahrenheit. Manufacturer's 3-year limited warranty.
*shipping this item requires insurance, please add an additional $0.50

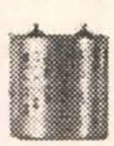
Lightwave 2000 Flashlight $29.95
Four super-bright white LEDs replace the bulb you'd find in a traditional flashlight, providing a long-lasting high-intensity light. LED lights mean your flashlight will last about 14 times longer than a regular flashlight, and these flashlights are waterproof and shockproof. Ideal for short-range use in cars, planes, etc. Flashlight requires 3 AA batteries (included). Manufacturer's limited lifetime warranty even includes the LED lights!

Spectrum LED A Rainbow of Light! $5.95
Imagine an LED capable of producing all three primary colors in the same package! The entire spectrum, including near-white, can be created! Imagination becomes reality with this T 1-3/4 multi-color LED. Here's the technology: a red chip, a green chip, and two blue chips encased in a diffused T1-3/4 package. Using various current combinations, you can produce red, orange, yellow, green, aqua, blue, violet or white light! Detailed spec sheet included. What can you do with these (beyond the obvious amaze your friends!)? Create a single indicator system, designate various controls by color, make a multi-color bargraph, make your project something out of the ordinary with multicolor LEDs!

Lighted Screwdriver Supertool! $9.95
At first glance, this appears to be an ordinary screwdriver, but press a button on the base and two lights illuminate the area you are working on. Nifty, huh? But wait, there's more! The seven interchangeable bits are stored right there at the base of the screwdriver (6 storage slots) for easy access. No handles to unscrew or tool boxes to dig through. Hey, you ain't seen nothin' yet...remove the bit and the magnetic retrieval tool telescopes from the screwdriver shaft! Incredible!!! Of course, the comfort grip handle and rugged construction are icing on the cake! Definitely a 'gotta have it' tool!

The Photon Microlight II
A super bright keychain LED flashlight, push to light or switch on for continuous bright illumination. available in a variety of colors. Blue, Green, White, Turquoise, Red, Yellow, or Orange $15.95 (please specify)

AMAZING MINI MICRO FM RADIO! $7.50
Much lighter than a heavy jam box with really good sound! This tiny radio (1.5"x1.06"x0.38") has a seek button, reset control, and an on/off switch. Personal listening has never sounded better! Ideal for ballgames, beaches, and workouts. Battery and nugget style earphones included.



Geophone vibration sensing kit *Detect a fly stomping across the desk!*
Well maybe not that sensitive, but almost. These vibration sensors made by Geosource® were used in oil exploration to determine geological statistics. They are made with a magnet suspended in a coil and are very sensitive to vibration. Compact size, the unit measures approx. 1.6" high and 1.2" dia.
The kit includes a geophone vibration sensor along with parts to build a basic detector that will light an LED. In addition we include a schematic that will show you how to operate a relay. The sensitivity is adjustable, so you can set it to detect elephants and other small creatures. Similar units were used by our armed forces to detect enemy troop movements...the perfect device to alert you to the pitter patter of little Leroy's feet! Unit sensitivity can be set high enough to detect a business card dropped on a table, and we've made it work with vibrations up to 40 feet away! Earthquake or Aunt Agatha...you decide! It's a fun gadget with many uses.
COMPLETE GEOSENSOR KIT....$ 9.95 GEOSENSOR UNIT ONLY....$7.95

RF LINEAR POWER BOOSTER AMPLIFIER KIT $39.95
A quick and simple boost for signal generators, transmitters, and other low power devices, this kit can boost power up to 1 watt over a frequency range of 100 KHz to over 1000 MHz. Operates on 12 to 15 vdc @ 250 mA, via a 2.1mm male power jack. 38 dB gain at 10 MHz, 10dB at 1000 MHz. Optional case $14.95

TV TRANSMITTER KIT $27.95
Tired of lugging the VCR to another room to see a movie while Aunt Martha watches reruns of the Julia Child special on PBS? Sick of stringing wires through the house so Junior can watch the latest Power Ranger movie in the comfort of his room? Never fear, we've got the solution! This kit allows you to send any audio and video source, like a VCR or TV camera, to any TV set for up to 300 feet. With this little kit, you're the producer and the programming director of your own TV station. Tunable to any TV chahnnel 2-6, runs on 12 VDC, and accepts standard audio and video signals. Optional matching case set, $14.95

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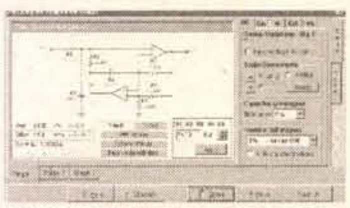

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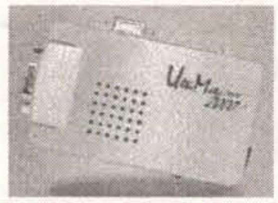

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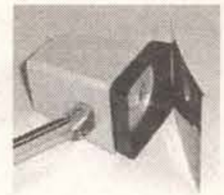

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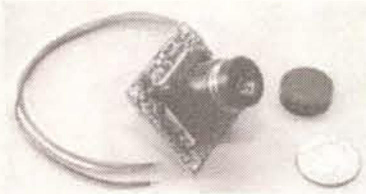
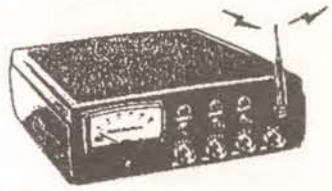


ULTRA LOW-LIGHT COLOR — 470 line/0.3 lux camera. CNL-11-C-HR, 1.5" x 1.5" x 1", 1/3" CCD board camera with 3/6mm F2.0 lens. Excellent color rendition using Sony chipset. 12VDC @ 240 mA. Optional 6, 8, 12mm lenses. **Special $179/each**. Matco, Inc., Schaumburg, IL, 1-800-719-9605, sales@matco.com or visit/order on-line at www.matco.com



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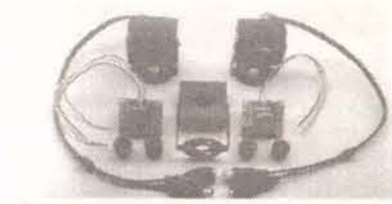

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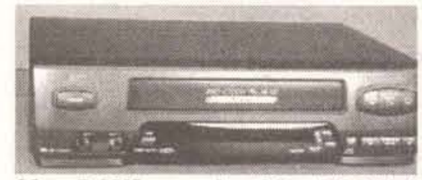

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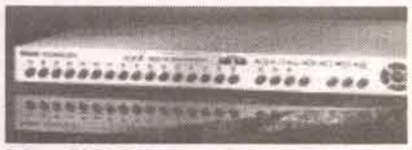

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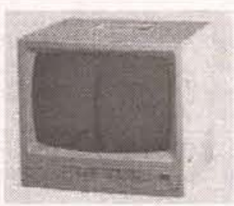

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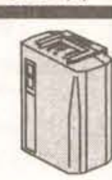

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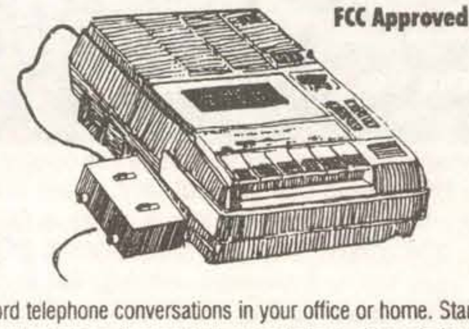

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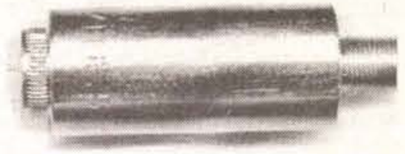

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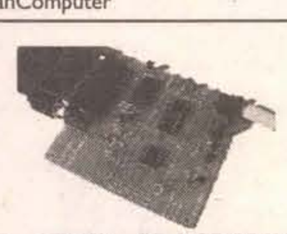

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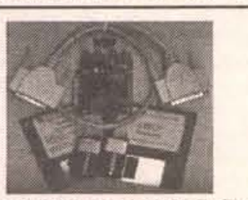

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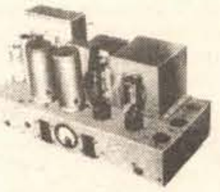

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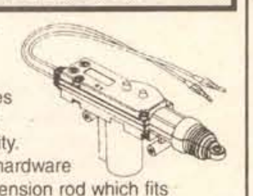

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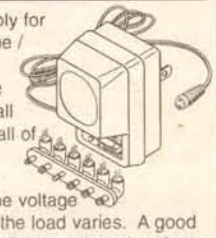

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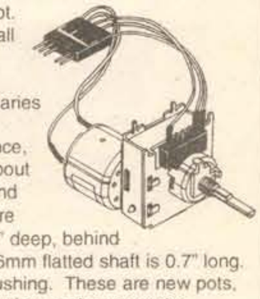

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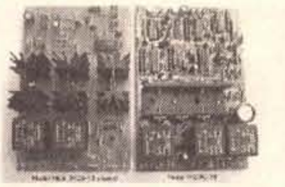

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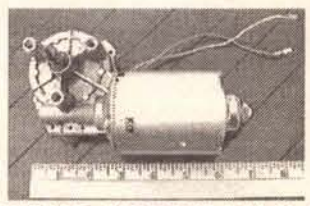

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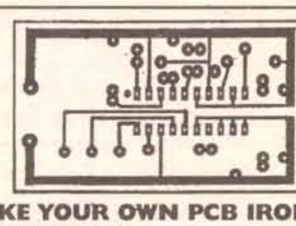

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Continued on page 70

by Jon Varteresian

DC Motor Speed Controller

Introduction

I recently bought a battery-powered quad for my daughter who has trouble using her legs. She presses a button on the handle bar to energize the motor, and when she lets go, it stops. Since the quad makes her extremely mobile, she loved it immediately, but the jerking starts as the motor powered full on made her a little unstable. I saw a need for a controller that would gently start the quad, ramping up the power and torque of the motor, thus removing any jarring starts. And since I was at it, I added a maximum speed control so she could use it in the house at a reduced speed. She can also control the speed of the motor with a potentiometer which, when adjusted, smoothly controls the acceleration and deceleration.

How it Works

The heart of the DC motor controller is a Microchip Technology PIC12C671. The use of a microcontroller allows extreme control over the motor with minimal hardware.

The DC motor controller uses pulse width modulation (PWM) techniques to ramp the power applied to a DC motor up and down. A ramp from full off to full on is completed in approximately two seconds. The ramp characteristics are completely customizable in firmware to your exact specifications. For example, you could apply an exponential ramp-up over the two seconds, or ramp up to 90% of the max speed in the first second and the remaining 10% over the remaining second, or even a ramp-

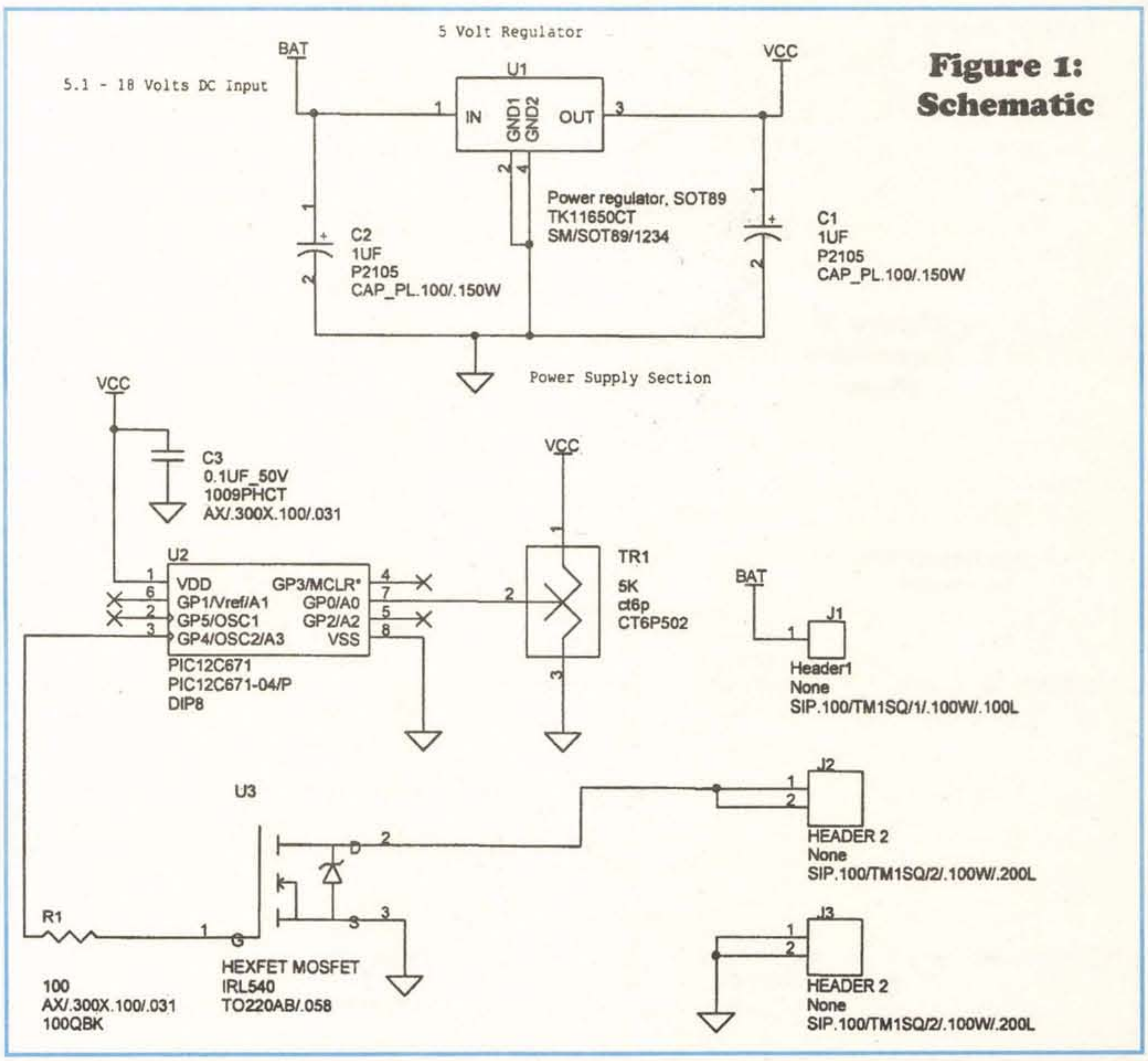

Figure 1: Schematic

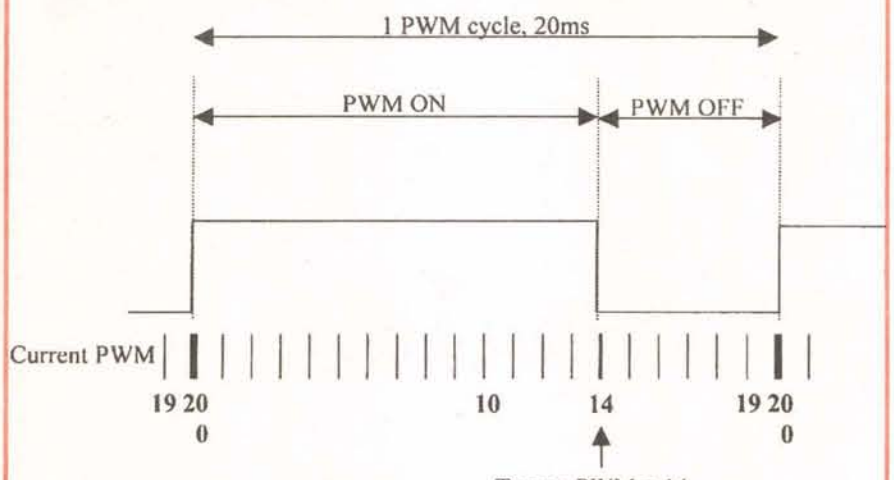

Figure 2: PWM Waveform

up over the first second and a ramp-down over the second. The firmware in this article ramps up the power to the motor linearly. To change how the PIC energizes the motor, you only have to enter your desired PWM curve into a table in the firmware (more on that later).

The firmware assembly and compiled code are available at the *Nuts & Volts* website at www.nutsvolts.com.

The DC motor controller can handle up to 28 amps and 18 volts. The HEXFET is packaged in a TO-220 and will require a heatsink at high currents. It can be used in one of two modes:

1. With the potentiometer adjusted to select the maximum speed desired, power can be applied to the circuit and the PIC will ramp the power to the DC motor based on the power table up to the desired maximum, thus providing a controlled acceleration. When power is removed, the motor will ramp down based on the momentum provided by the load. Usually, this provides a smooth deceleration.

2. Power can be consistently applied to the circuit and the motor speed will be controlled by the potentiometer. The acceleration and deceleration will be controlled by the PIC based on the power table.

Before we get into the details of these modes, a closer look at the details of the circuit is in order.

The Circuit

The schematic for the motor controller is shown in Figure 1. It contains a Microchip PIC 12C671 microcontroller, a voltage regulator, a high power HEXFET, and a sprinkle of resistors and capacitors. Easily built in an evening, the applications for this circuit are extensive.

U1, a TK11650UTL low drop-out power regulator, regulates the battery IN voltage to five volts for the PIC. The battery voltage can be anywhere from 5.1 volts to 18 volts. Capacitors C1 and C2, 1uF, are used as general filters. U1 is packaged as a SOT-89. This is a surface-mount device, but relatively large and easy to work with. It is used in this design because it is easy to get, has an extremely low drop-out voltage (80mV typical at 30mA load current), and requires very few external components. U2, a PIC12C671, is the microcontroller. It is operating in internal 4MHz clock mode. C3, a 0.1uF capacitor, limits high-frequency transients on the PIC's voltage rail. This includes transients that may be externally present on the voltage rail, as well as transients that the PIC may generate. It really is not needed in this design, but it is good design practice. TR1, a 5k potentiometer, is used to set the maximum speed and resultant torque of the motor. U3, a IRL540 HEXFET, is responsible for PWMing the motor's return. This HEXFET has a special feature in that unlike most FETs, it is logic level controlled. This means that a relatively low Vgs is required to fully turn on the FET. Specifically, only around 3.5 volts is required to fully turn on the HEXFET at 25 degrees Celsius and 28 amps drain current. As the drain current drops, so does the Vgs required to fully turn on the FET. R1, one 100-ohm resistor, limits gate current in the event something 'unexpected' happens.

Pin 3 of the PIC is configured as an output, and is used to drive the gate of the HEXFET. Pin 3 is a logic level high — +5 volts — when we want the FET and motor on. Pin 3 is a logic low, or 0 volts, when we

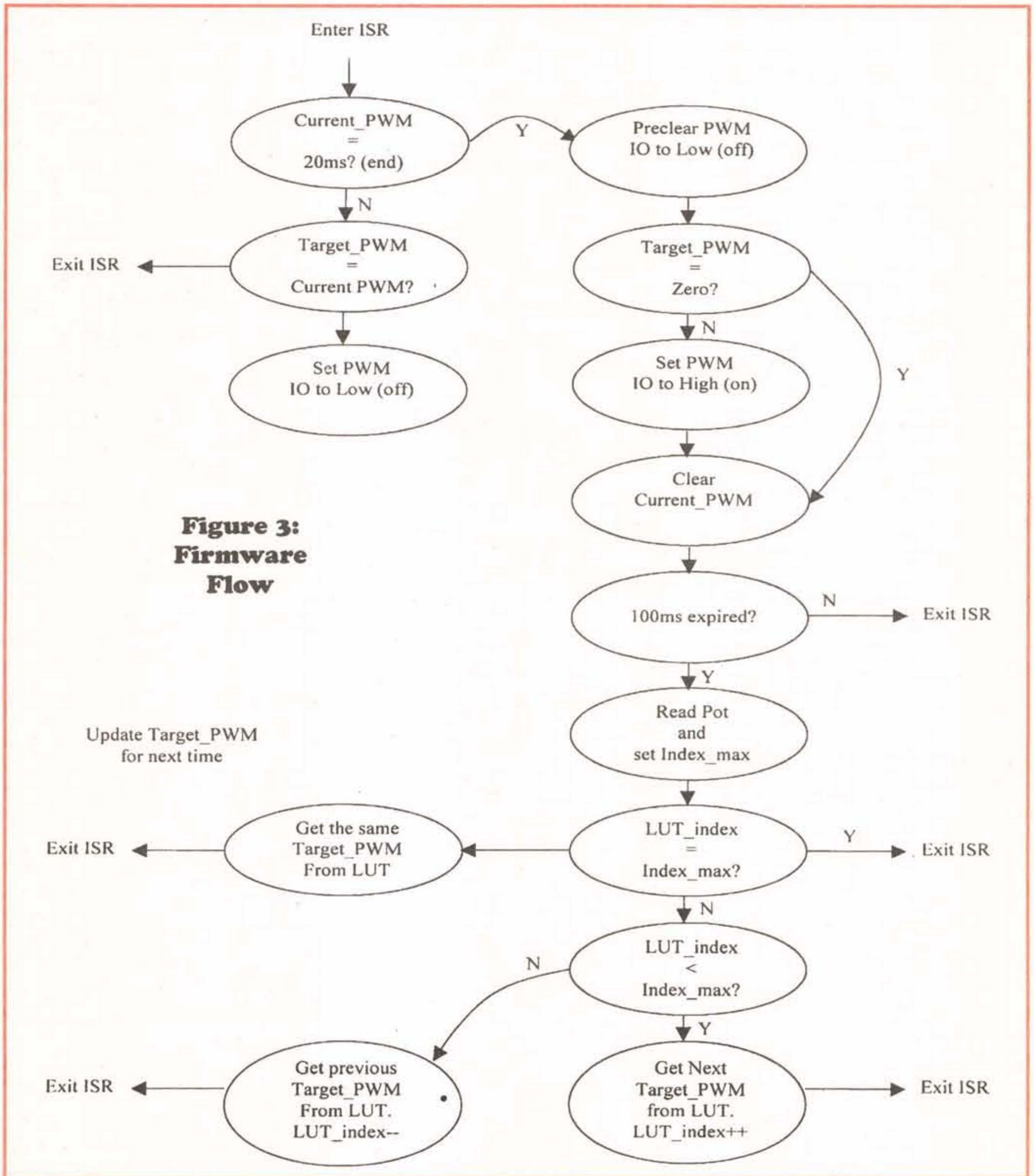

Figure 3: Firmware Flow

want the FET and motor off.

There are only three connections to the circuit and they are described below.

Battery – This connection draws less than five milliamps. Connect this to a voltage source greater than 5.1 volts and less than 18 volts. This connection powers the on-board regulator that generates +5 volts for the PIC

Ground – Connect these pins to ground. For a small load of one amp or so, you only have to connect a single wire. For a larger load, connect both to ground. This will help limit the amount of voltage drop across the wires, due to the wires finite resistance.

Motor Return – Connect these pins to the negative or output side of the motor. These connections connect directly to the drain of the HEXFET, and will be PWM'ed to control the amount of power going to the motor.

You may have noticed that this design does not contain a fuse. This is because most of the powered vehicles manufactured today have an integral fuse in the battery. If your application does not have a built-in fuse, you should add one.

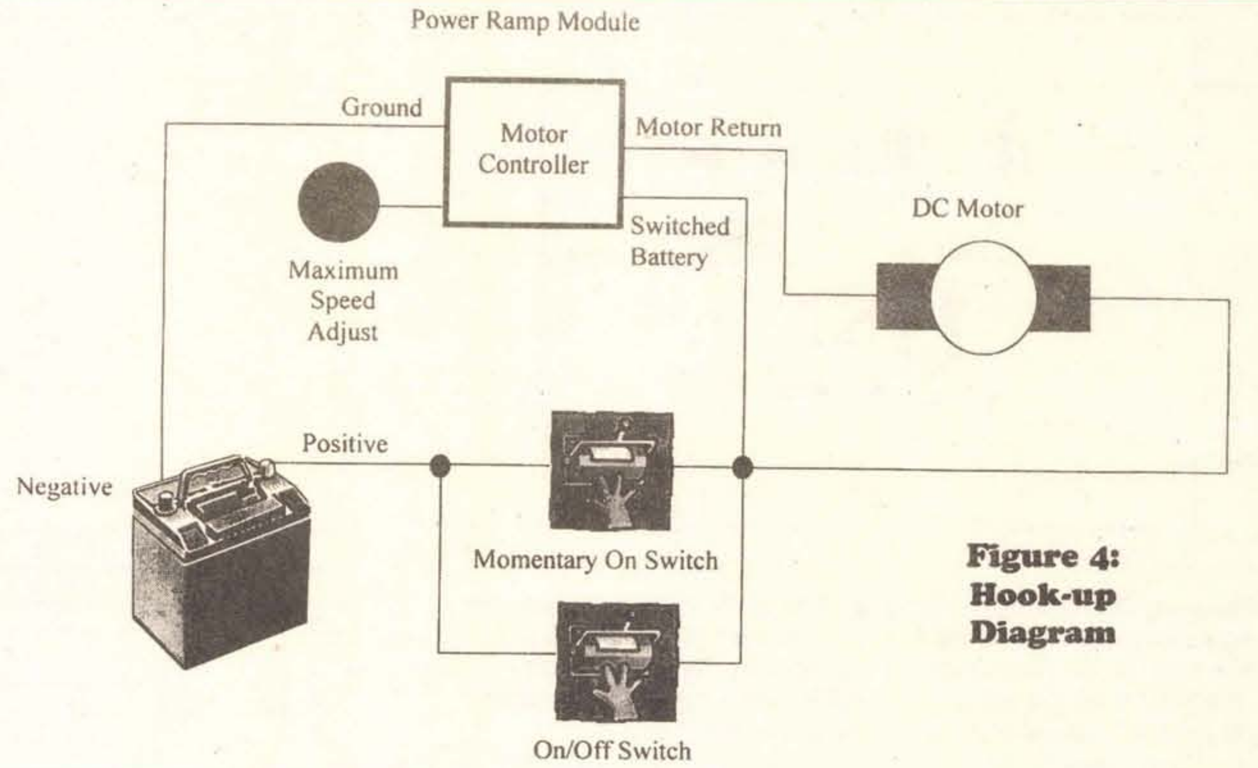

Figure 4: Hook-up Diagram

The Firmware

Before we examine the PIC firmware, a brief discussion of pulse width modulation is in order. PWM is nothing more than turning a signal on and off very quickly. Figure 2 illustrates the terminology for a PWM signal customized for this application. The PWM frequency is defined as the cycle time in Hertz. In the figure shown, the frequency is 1/20ms or 50 Hz. The duty cycle is defined as the ratio of the on time divided by the off time for a given period. In the figure shown, the duty cycle is 14ms/20ms or 70%. Note that the ON time may be a logic low or a logic high depending on your application. If this waveform shown in Figure 2 represented the voltage applied to a motor, the motor would be receiving 70% of the maximum possible power.

By lowering the applied power, we lower the speed and torque of the motor as well. In this way, we can control the speed and torque of the motor. Keep in mind that just because we apply a 25% duty cycle PWM to our motor, this does not mean that the motor will run at 25% of its maximum speed. The relationship between power, speed, and torque is not initially intuitive, and does require a little experimentation, especially when the PWM duty cycle is small. In our case, it was desirable for the motor speed to ramp up as linearly as possible, thus removing any jarring starts. The target PWM value (in milliseconds), along with its associated duty cycle for our case, is shown in Table 1.

Each PWM step is held for 100 milliseconds. With a total of 21 steps, the entire ramp up sequence takes two seconds.

When +5 volts is applied, the PIC initializes all software variables, configures all I/O, and sets up timer0 for internal clocking and a prescaler value of four. This means that every time the internal instruction clock ticks four times, the timer will increment by one. Remember that the PIC is executing instructions at (1/4 MHz * 4) or one microsecond. Since timer0 has an eight-bit resolution, it will overflow every 256 * 4, or 1.024 milliseconds. For this application, this is close enough to 1 millisecond. This millisecond overflow triggers an interrupt service routine that contains all the code for this design. The flow diagram for this ISR is shown in Figure 3.

The Current_PWM variable counts each one millisecond step in the 20-millisecond period and then resets to zero. Target_PWM defines the On portion of the PWM duty cycle for the current 100 millisecond period, and PWM_MAX limits how high the duty cycle can get.

The first thing the PIC does is check to see if the PWM I/O line

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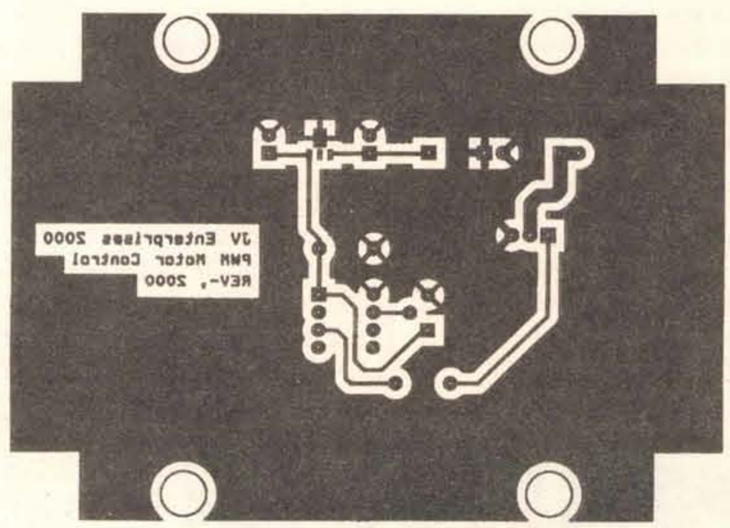
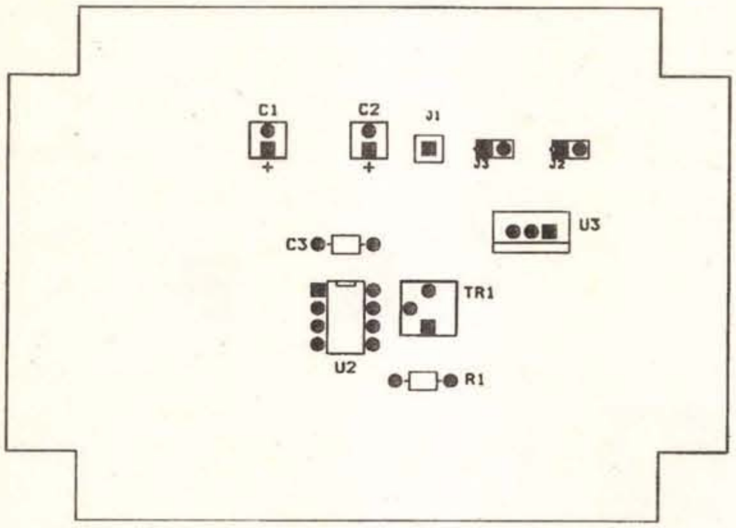
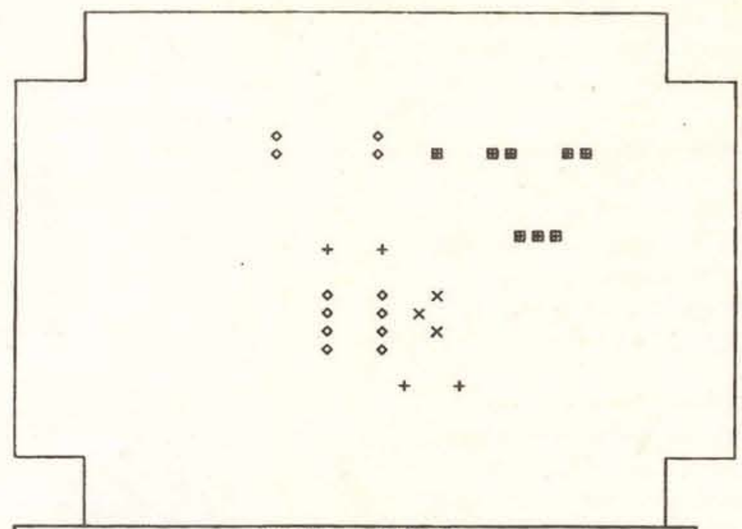


Step #	PWM On time in milliseconds	Target Duty Cycle
0	0	0.00 (Off)
1	2	0.10
2	4	0.20
3	5	0.25
4	6	0.30
5	7	0.35
6	8	0.40
7	9	0.45
8	10	0.50
9	11	0.55
10	12	0.60
11	13	0.65
12	13	0.65
13	14	0.70
14	15	0.75
15	16	0.80
16	17	0.85
17	18	0.90
18	19	0.95
19	20	1.00
20	20	1.00 (On)

Table 1: PWM and Duty Cycle





DRILL CHART				
SYM	DIAM	TOL	QTY	NOTE
×	0.030		3	
+	0.031		4	
◇	0.034		12	
■	0.040		5	
■	0.058		3	
TOTAL			27	

should be set to ON. This is done by checking to see if the Current_PWM variable is equal to 20 milliseconds. If it is, the PWM is set ON unless the TARGET_PWM variable is set to zero. This check allows the PWM output to be fully off. Current_PWM is then cleared to prepare for the next cycle. If the target PWM has been applied for 100 milliseconds, it is time for the next PWM step. The PIC reads the potentiometer to get the maximum PWM value and then picks the next Target_PWM value from the look-up table based on whether the current Target_PWM is equal to, greater than, or less than the maximum desired.

If the Current_PWM is not 20 milliseconds, the PIC checks to see if the Current_PWM is equal to the Target_PWM value. If it is, the ON portion of the PWM is finished. The PIC sets the PWM I/O line to OFF. Nothing else happens until the PWM cycle is complete, and then the whole thing starts over.

Should the PWM_MAX value fall or rise above the Target_PWM, the PIC will track to the new value smoothly, spending the desired 100 milliseconds at each step.

How to Use it

Now that you know how the circuit works, let's hook it up. Figure 4 contains the hook-up diagram for Mode 1 described above. In this application, somebody presses a momentary ON switch and the DC motor controller ramps the speed of the motor up to the desired maximum over a two-second time period. When the button is released, the motor comes to a stop. When the button is pressed again, the whole process repeats. The hook-up diagram for Mode 3 is similar except that the power ramp receives power all the time. Here the potentiometer is used to increase and decrease the motor's speed.

Construction

Construct the motor controller on standard perf board and point-to-point wire it, or use the supplied foil patterns to make your own printed circuit board. There is no special construction restrictions, however, keep in mind that for large currents, or extended periods of use, the FET will get hot. A heatsink, or a protective enclosure may be necessary. Also remember to use the correct gauge of wire; 12 gauge should suffice for most applications. You can use 14- or 16-gauge wire for low-current applications. **NV**

Bill of Materials

All components available from www.digikey.com

U1	Fixed five-volt power regulator	TK11650CT
C1,C2	1uF Tantalum capacitor	P2105
U2	PIC microcontroller	PIC12C671-04/P
-	Eight-pin socket	-
TR1	5k potentiometer	575SS502
R1	100 ohm 1/8 watt resistor	100QBK
U3	Power HEXFET	IRL540
Misc.:	Perf board, hook-up wire, enclosure, and heatsink.	

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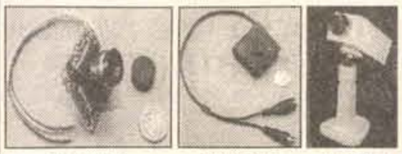

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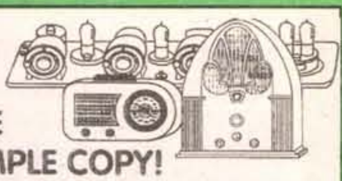

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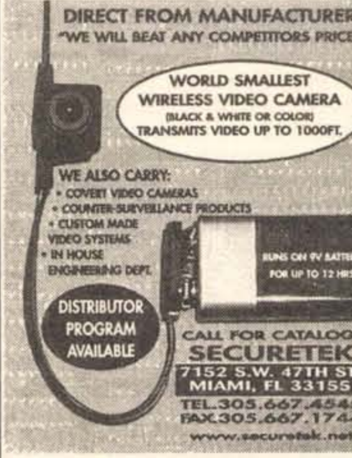

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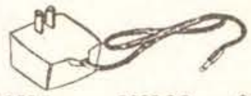

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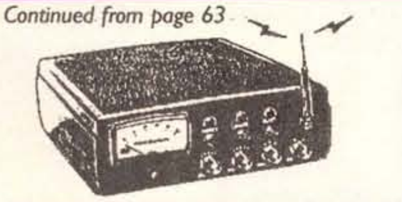
Continued from page 63



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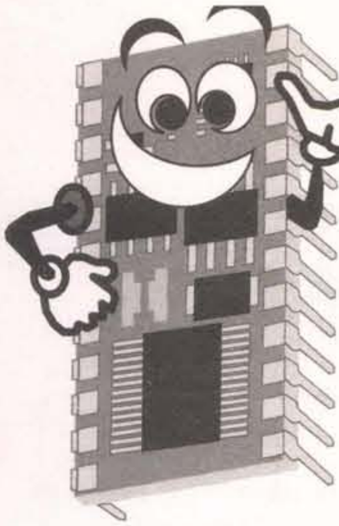

by Jon Williams

Stamp Applications

THERE'S A NEW STAMP IN TOWN — PART 2

Putting the Spotlight on BASIC Stamp Projects, Hints, and Tips

Last month, we introduced the BS2p and some of its really great features: LCD support, Dallas 1-Wire™ support, I2C ... big improvements over the BS2sx and BS2e. And thanks to some astute beta testers and the hard work of the Parallax engineering staff (specifically, Chuck Gracey), it's actually been improved even more. Don't worry, the code is frozen now and about the time you're reading this article, the BS2p should be on the streets and making a lot of Stamp programmers very, very happy.

Last month, we talked about LCDs, 1-Wire™, and I2C. This month, we'll talk about the updates, pin polling (firmware interrupts), and how to use the 40-pin BS2p.

Well, we made ... 2001. Yippee!!! You know, there are some calendar-math fanatics out there who insist that this is the year that actually begins the new millennium. I don't know about that, but what I do know is that this is the year of the BASIC Stamp2-SX Plus: the BS2p. All millennium-hype aside, this is the best new Stamp in years.

1-Wire Update

The Dallas 1-Wire™ routines have been updated to allow bit-level support and high-speed communications. We can use the bit-mode capability with the DS1820 to determine when the conversion is actually done instead of waiting for some default time (500 milliseconds is suggested by Dallas). Jeff Martin at Parallax showed me this trick and it turns out that the DS1280 will actually convert the temperature in about 225 to 250 milliseconds. I know that 250 milliseconds doesn't sound like a big savings when dealing with one sensor, but on a busy 1-Wire network, it could be valuable.

Take a look at Listing 1 (an update from last month). Aside from adding some useful constants, there is a new routine called **WaitForConversion**. After the **ConvertTemp** has been sent, we can use bit-mode access to determine when the conversion is done. When we read back a 1, the conversion is complete and we can move on to retrieving the newly measured temperature. The reason we allow 25 milliseconds between checks is to let the DS1820 finish the temperature conversion.

You may have noticed that **OWIN** and **I2CIN** do not have a time-out parameter in their syntax. The BS2p defines this internally so it won't "hang" if no input is returned from a device.

Effective Use Of EEPROM Space

Between last month and this one, a new command has been added: **STORE**. This syntax is simple:

```
STORE location
```

Location is the program slot (0 to 7) to be used as the target for **READ** and **WRITE**. The default location number is the same as the current program and gets changed to the new program slot whenever the **RUN** command is issued. The neat thing about **STORE** is that now we can take advantage of unused program slots and treat them like one large, flat EEPROM block.

Listing 2 is a short demo that shows how to take advantage of **STORE** and all the available EE space in the BS2p. The routines in this program would be useful in a data logging application. For our demo though, all we need to do is connect to the BS2p.

At the top is a constant called **FirstSlot**. This sets the first available program slot to be used as general-purpose storage space. The demo assumes that program slot 0 will be used for main code and program slot 1 will be used for subroutines. This leaves program slots 2 through 7 (12,288 bytes) available for storage. Of course, you can adjust this for your own needs.

Now that we know where we can start storing data, we can calculate how much is available. This is important so that we don't overwrite a location or read back the wrong one. Both subroutines check to make sure that we are attempting to write to or read back a valid address.

The program slot for our "big EEPROM" is calculated by dividing the required address by 2,048 (the EE size for each slot) and adding the **FirstSlot** constant. The offset into the correct slot is calculated by using the modulus operator (//). The **STORE** command is used to set the correct program slot and **WRITE** and **READ** are used as they normally would be.

This feature is significant and we can thank Stamp guru, Tracy Allen, for suggesting it. If the available program slots don't provide enough EEPROM for your application, remember that there are a bunch of I2C EEPROMs that the BS2p can connect to with ease.

Pin Polling (Firmware Interrupts)

As much as we'd all like it to be, the BS2p is not capable of handling true interrupts — that's hard to do for any interpreter and the compact size of the PBASIC interpreter makes it even tougher. What the BS2p can do, however, is check on pins between PBASIC statements and take a specified action. When set up and enabled, the BS2p performs the following actions on a polled interrupt:

1. Nothing
2. Set an output pin to specified state
3. Run another program
4. Wait (pause program) until interrupt condition occurs
5. Any combination of 2, 3, and 4

Let me explain again so we're absolutely clear. When set up and enabled, the BS2p will check the state of polled-input pins between each PBASIC instruction. If the specified input condition is met, the "interrupt" state is made true and specified action(s) will be taken.

To define input pins that will be polled, we'll use **POLLIN**. Here's the syntax:

```
POLLIN pin,state
```

The pin parameter will always be 0 to 15 and state will be 0 (low) or 1 (high). When activated, the specified pin(s) will be polled between PBASIC instructions.

When the interrupt state is true, polled-output pins can be

THERE'S A NEW STAMP IN TOWN

controlled. Once set up, the control over these pins is automatic and follows the interrupt condition. To define output pins, we'll use **POLLOUT**.

```
POLLOUT pin,state
```

The parameters are the same as with **POLLIN**, except that we're controlling an output. The state will be set on the specified pin when the interrupt condition is true.

With polled-inputs and outputs defined, we'll use **POLLMODE** to enable them.

```
POLLMODE mode
```

The mode parameter will be from 0 to 15 with the following definitions:

0. Deactivate polling and clear polled-inputs and outputs definition
1. Deactivate polling and save polled-inputs and outputs definition
2. Activate polling with polled-outputs only
3. Activate polling with polled-run action only
4. Activate polling with polled-outputs and polled-run action
5. Clear polled-inputs configuration
6. Clear polled-outputs configuration
7. Clear both polled-inputs and polled outputs

Modes 8 through 15 are the same as 0 through 7 except that the interrupt condition is latched.

Here's a really simple little code snippet that will demonstrate polled-inputs and outputs.

```
Setup:
  POLLMODE 0      ' clear and disable polling
  POLLIN 4,0      ' interrupt when pin 4 is low
  POLLOUT 0,1     ' make pin 0 high on interrupt
  POLLMODE 2      ' activate polled-outputs

Loop:
  DEBUG "Waiting for interrupt",CR
  PAUSE 100
  GOTO Loop
```

When you run this code, you see a **DEBUG** screen with the "Waiting ..." message happily scrolling by. Now press and hold the button connected to pin 4. The LED connected to pin 0 will light. Now release the button and notice that LED goes out.

With the ability to control outputs with polled-inputs, you can create a "background logic gate" that operates while our Stamp program is running. Add this line to the code above and notice that either pin (4 or 5) will light the LED – a background OR gate.

```
POLLIN 5,0      ' interrupt when pin 5 is low
```

The nature of the BS2p lets us control polled-output pins with standard output pins. Try this code:

```
Setup:
  POLLMODE 0      ' clear and disable polling
  POLLIN 0,0      ' interrupt when pin 0 is low
  POLLOUT 1,1     ' make pin 1 high on interrupt
  POLLMODE 2      ' activate polled outputs

Loop:
  TOGGLE 0        ' toggle LED on pin 0
  PAUSE 100
  GOTO Loop
```

Without polling defined, the only thing that would happen is that the LED on pin 0 would blink (due to the **TOGGLE** command). With polling active though, the LED on pin 1 will blink at the same rate as the LED on pin 0 (in this case, in the opposite state).

Keep in mind that the interrupt state is a global condition and if none of the polled-input pins meet their requirements, the interrupt state will be cleared. There will be times when you want to monitor a number of pins and take a specific action based on the inputs. This can be accomplished by latching the interrupt condition and checking to see what pin(s) caused the interrupt state.

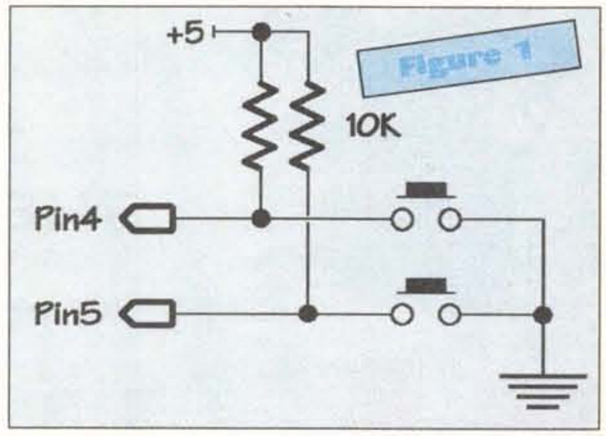

Figure 1

Listing 3 is a simple alarm program that latches the interrupt condition. Pins 4 and 5 are set up to create an interrupt when pulled low. When the interrupt condition is true, the Alarm LED on pin 0 is lit. In order to determine which pin(s) caused the interrupt condition, **POLLMODE 10** (control outputs and latch interrupt condition) is used.

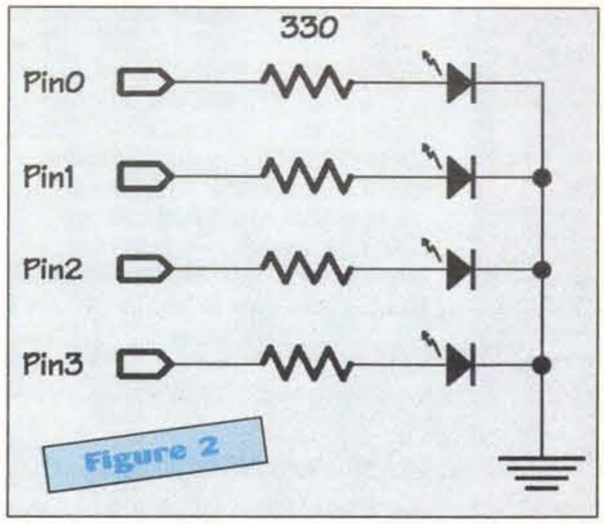

Figure 2

During the loop, scratchpad location 128 is read to determine any active interrupt pins. Since the interrupts have been latched, the variable ***iPins*** will show which pins were active during the polling cycle. With this information, we can create a simple display. Once we've taken action on the interrupt, we can reset everything by re-issuing the **POLLMODE** command.

In the examples so far, our program spent time in a loop waiting for an interrupt to happen. With **POLLWAIT**, the BS2p can suspend program operation until the interrupt condition is true. When the interrupt condition is true, the program resumes at the next line.

```
POLLWAIT period
```

POLLWAIT is very similar to **NAP** in that it puts the BS2p into low-power mode. Based on the period, the BS2p will "wake" from the low-power and scan the defined polled-input pins. If any of the conditions are met, the program continues, otherwise the BS2p goes back into low-power mode. The possible values for period are:

0. 18 ms
1. 36 ms
2. 72
3. 144 ms
4. 288 ms
5. 576 ms
6. 1152 ms (1.152 seconds)
7. 2304 ms (2.304 seconds)
8. Wait without low-power mode

Just as with **NAP**, any outputs will glitch when the BS2p comes out of low-power mode (period from 0 to 7) to do its check. Try this code:

```
HIGH 3            ' turn LED on pin 3 on

POLLIN 5,0        ' scan pin 5 for low input
POLLOUT 2,1       ' light LED on pin 2 during interrupt
POLLMODE 2        ' activate polled-output control

Loop:
  POLLWAIT 0      ' low-power mode for 18 ms
  TOGGLE 1        ' toggle LED on pin 1
  GOTO Loop
```

THERE'S A NEW STAMP IN TOWN

Listing 1

```
' Listing 1
' Nuts & Volts - January 2000

' {$STAMP BS2p}

' -----[ Title ]-------------------------------------------------------
-
'
' File...... DS1820b.BSP
' Purpose... BASIC Stamp SX Plus <--> DS1820 Demo
' Author.... Jon Williams
' E-mail.... jonwms@aol.com
' Started... 04 NOV 2000
' Updated... 05 DEC 2000


' -----[ Program Description ]-----------------------------------------
-
'
' This program reads and displays the ROM code and temperature data from a
' DS1820 (1-wire) sensor.
'
' Program requires 2x16 LCD
'    - LCD.E       --> Pin0 (pulled down [to ground] through 4.7K)
'    - LCD.R/W     --> Pin2 (or grounded for write-only operation)
'    - LCD.RS      --> Pin3
'    - LCD.D4      --> Pin4
'    - LCD.D5      --> Pin5
'    - LCD.D6      --> Pin6
'    - LCD.D7      --> Pin7


' -----[ Revision History ]--------------------------------------------
-
'
' 05 DEC 2000 : Added status check for end-of-conversion


' -----[ I/O Definitions ]---------------------------------------------
-
'
LCDpin          CON     0               ' data on pins 4 - 7
DS1820pin       CON     9


' -----[ Constants ]---------------------------------------------------
-
'
' LCD control characters
'
NoCmd           CON     $00             ' just print
ClrLCD  CON     $01                     ' clear the LCD
CrsrHm  CON     $02                     ' cursor home
CrsrLf  CON     $10                     ' cursor left
CrsrRt  CON     $14                     ' move cursor right
DispLf  CON     $18                     ' shift display left
DispRt  CON     $1C                     ' shift displayright
DDRam           CON     $80             ' Display Data RAM control
Line1           CON     $80             ' address of line 1
Line2           CON     $C0             ' address of line 2

DegSym          CON     223             ' degrees symbol

' 1-Wire Support
'
OW_FERst CON    %0001                   ' Front-End Reset
OW_BERst CON    %0010                   ' Back-End Reset
OW_BitMode      CON     %0100
OW_HighSpd      CON     %1000

ReadROM         CON     $33             ' read ID, serial num, CRC
MatchROMCON     $55                     ' look for specific device
SkipROM         CON     $CC             ' skip ROM (one device)
SearchROM       CON     $F0             ' search

' DS1820 control
'
ConvertTemp     CON     $44             ' do temperature conversion
ReadScratch     CON     $BE             ' read DS1820 scratchpad


' -----[ Variables ]---------------------------------------------------
-
'
idx             VAR     Byte            ' loop counter
romData         VAR     Byte(8)         ' ROM data from DS1820
tempIn          VAR     Word            ' raw temperature
sign            VAR     tempIn.Bit8     ' 1 = negative temperature
tInLow          VAR     tempIn.LowByte
tInHigh         VAR     tempIn.HighByte
tSign           VAR     Bit
tempC           VAR     Word            ' Celsius
tempF           VAR     Word            ' Fahrenheit


' -----[ EEPROM Data ]-------------------------------------------------
-
'


' -----[ Initialization ]----------------------------------------------
-
'
LCD_Setup:
  LCDCMD LCDpin,%00110000 : PAUSE 5     ' 8-bit mode
  LCDCMD LCDpin,%00110000 : PAUSE 0
  LCDCMD LCDpin,%00110000 : PAUSE 0
  LCDCMD LCDpin,%00100000 : PAUSE 0     ' 4-bit mode
  LCDCMD LCDpin,%00101000 : PAUSE 0     ' 2-line mode
  LCDCMD LCDpin,%00001100 : PAUSE 0     ' no crsr, no blink
  LCDCMD LCDpin,%00000110               ' inc crsr, no disp shift


' -----[ Main Code ]---------------------------------------------------
-
'
Main:
  LCDOUT LCDpin,ClrLCD,["BSP <---> DS1820"]      ' splash screen
  PAUSE 2000

DisplayROM:
  LCDOUT LCDpin,ClrLCD,["DS1820 ROM:"]
  OWOUT DS1820pin,1,[ReadROM]                    ' send Read ROM command
  OWIN  DS1820pin,2,[STR romData\8]              ' read serial number & CRC
  LCDCMD LCDpin,Line2
  FOR idx = 0 TO 7
    LCDOUT LCDpin,NoCmd,[HEX2 romData(idx)]      ' show ID, serial num, CRC
  NEXT

  PAUSE 5000

TempDemo:
  LCDOUT LCDpin,ClrLCD,["CURRENT TEMP:"]

ShowTemp:

  ' * send conversion command
  ' * check for conversion complete
  ' * send read scratch ram command
  ' * grab the temperature

  OWOUT DS1820pin,OW_FERst,[SkipROM,ConvertTemp]

WaitForConversion:
  PAUSE 25
  OWIN DS1820pin,OW_BitMode,[tempIn]
  IF tempIn = 0 THEN WaitForConversion

  OWOUT DS1820pin,OW_FERst,[SkipROM,ReadScratch]
  OWIN  DS1820pin,OW_BERst,[tInLow,tInHigh]

  tSign = sign                                   ' save sign bit
  tempIn = tempIn/2                              ' round to whole degrees
  IF tSign = 0 THEN NoNeg1
  tempIn = tempIn | $FF00                        ' extend sign bits for negs

NoNeg1:
  tempC = tempIn                                 ' save Celsius value
  tempIn = tempIn */ $01CC                       ' multiply by 1.8
  IF tSign = 0 THEN NoNeg2                       ' if neg, extend sign bits
  tempIn = tempIn | $FF00

NoNeg2:
  tempF = tempIn + 32                            ' finish C -> F conversion

  ' display temps
  '
  LCDOUT LCDpin,Line2,[SDEC tempC, DegSym, " C"]
  LCDOUT LCDpin,NoCmd,[" / ", SDEC tempF, DegSym, " F"]
  LCDOUT LCDpin,NoCmd,[REP " "\6]

  GOTO ShowTemp                                  ' update temp display
```

THERE'S A NEW STAMP IN TOWN

When the program starts, the LED attached to pin 3 will light. Look carefully. Notice the apparent pulsing of this LED? This happens when the BS2p comes out of low-power mode and all pins are momentarily made inputs. You can see the change by setting the period to a different value. What you'll observe is that as the period gets larger, the "glitching" becomes less frequent, but so does the polling frequency. Holding the button will make the interrupt active through every check and the LED on pin 0 will toggle at a rate determined by the **POLLWAIT** period.

For applications where low-power mode is not required and **POLLWAIT** is desirable, set the period to 8. This causes the BS2p to wait for the interrupt condition, but doesn't put it into low-power mode.

Finally, we can use **POLLRUN** to cause the BS2p to jump to another program slot when the interrupt condition is true.

```
POLLRUN program
```

The default program slot for **POLLRUN** is 0. If **POLLMODE** 3 or 4 is issued and no **POLLRUN** program was defined, the BS2p will jump to program 0 on the interrupt condition. If polled-outputs are also defined and enabled (**POLLMODE** 4), the outputs will be set before the new program is run. **POLLRUN** 3 and 4 have a "one-shot" behavior to prevent the BS2p from appearing to be locked up by continuously jumping to the specified program.

Pins, Pins, And More Pins

You asked for them, you got 'em. The BS2p comes in a 40-pin version that gives the Stamp user an extra set of 16 I/O pins. Using the additional pins is somewhat similar to using program slots – you have to alert the Stamp. All Stamp instructions that require pin numbers stay the same, that is, they expect a pin number from 0 to 15. What we have to do now is tell the Stamp which set of pins we want to use.

There are two ways to select the second set of I/O pins:

```
AUXIO          ' select auxiliary I/O pins
IOTERM 1       ' select auxiliary I/O pins
```

To switch back to the main I/O pins, we can use either of the following:

```
MAINIO         ' select main I/O pins
IOTERM 0       ' select main I/O pins
```

In case you're wondering, polled-pins can be defined on both sets of I/O groups and all of them are active, regardless of which set of I/O pins are in use at the time. You can even determine which of the 32 pins caused the interrupt condition by looking into the scratchpad RAM (see below).

Note that **MAINIO**, **AUXIO**, and **IOTERM** are not available on the BS2p-24 since it only has one set of 16 I/O pins.

Read-Only RAM Locations

As pointed out last month, the BS2p has twice as much scratchpad RAM (127 bytes) as the BS2sx. There are five bytes at the end of the scratchpad that are read-only and provide useful information

127 Current program (low nibble) and **STORE** location (high nibble)
128 Interrupt pin detection, main pins 0-7
129 Interrupt pin detection, main pins 8-15
130 Interrupt pin detection, auxiliary pins 0-7
131 Interrupt pin detection, auxiliary pins 8-15

Locations 128-131 can be used by your program to determine what pin(s) caused an interrupt condition. An active interrupt pin will be indicated by a 1, regardless of its input state (active-low or active-high). The bits in these locations are active only when the interrupt is active, so you may need to latch the interrupt condition to determine the cause after-the-fact.

More To Come

To be honest, only a very lucky handful of us have had the opportunity to play with the BS2p, but with it rolling into production that will change very soon. I really think that the BS2p will become my default Stamp. Oh, don't worry, I'm not going to force you to upgrade for future projects; most of my code will be backward-compatible with the BS2. That said, there are a lot of neat 1-Wire™ and I2C parts that I'm interested in experimenting with – and I'm sure you will to.

Be sure to visit the **Parallax** web site **(www.parallaxinc.com)** when you get the chance. With all the excitement surrounding the BS2p, they will be creating a separate support page for BS2p projects. Who knows, maybe they'll post one of yours ...

Until next time, Happy Stamping. **NV**

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jonwms@aol.com

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THERE'S A NEW STAMP IN TOWN

Listing 2

```
' Listing 2
' Nuts & Volts - January 2000

' {$STAMP BS2p}

' -----[ Title ]-----------------------------------------------
'
' File...... STORE.BSP
' Purpose... Uses STORE to create large, flat EE space
' Author.... Jon Williams
' E-mail.... jonwms@aol.com
' Started... 05 NOV 2000
' Updated... 05 DEC 2000


' -----[ Program Description ]---------------------------------
'
' This program demonstrates the use of STORE to create a flat
'EEPROM space from program slots 2 - 7 (12,000 bytes).  Program
'slot 1 is reserved for subroutines.


' -----[ Revision History ]------------------------------------
'


' -----[ I/O Definitions ]-------------------------------------
'


' -----[ Constants ]-------------------------------------------
'
FirstSlot CON 2                    ' start with pgm slot 2
MaxAddr       CON    8 - FirstSlot * 2048 - 1


' -----[ Variables ]-------------------------------------------
'
eeAddr        VAR    Word          ' flat EE address
eeData        VAR    Byte
slot          VAR    Nib           ' pgm slot for storage
addr          VAR    Word          ' address for storage


' -----[ EEPROM Data ]-----------------------------------------
'


' -----[ Initialization ]--------------------------------------
'
  eeAddr = 4090

' -----[ Main Code ]-------------------------------------------
'
Main:
  DEBUG Home,"BS2p STORE Demonstration",CR
  DEBUG "------------------------",CR,CR

  DEBUG "Big EE Size: ", DEC MaxAddr + 1, " bytes",CR,CR

  RANDOM eeData                              ' create data
  GOSUB WriteBigEE                           ' write to flat EE

  DEBUG "eeAddr..... ",DEC eeAddr,CR
  DEBUG   "slot....... ",DEC slot,CR
  DEBUG "addr....... ",DEC addr,CR,CR
  DEBUG "data out... ", DEC eeData,"   ",CR

  GOSUB ReadBigEE                    ' get data from flat EE

  DEBUG "data in.... ", DEC eeData,"   "

  eeAddr = eeAddr + 1 // MaxAddr
  PAUSE 250
  GOTO Main


' -----[ Subroutines ]-----------------------------------------
'
WriteBigEE:
  IF (eeAddr > MaxAddr) THEN NoWrite     ' check for bad eeAddr
  slot = (eeAddr / 2048) + FirstSlot     ' calc pgm slot
  addr = eeAddr // 2048                  ' calc address in slot
  STORE slot
  WRITE addr,eeData
NoWrite:
  RETURN


ReadBigEE:
  IF (eeAddr > MaxAddr) THEN NoWrite     ' check for bad eeAddr
  slot = (eeAddr / 2048) + FirstSlot     ' calc pgm slot
  addr = eeAddr // 2048                  ' calc address in slot
  STORE slot
  READ addr,eeData
NoRead:
  RETURN
```

Listing 3

```
' Listing 3
' Nuts & Volts - January 2000

' {$STAMP BS2p}

' -----[ Title ]-----------------------------------------------
'
' File...... ALARM.BSP
' Purpose... Simple alarm system demo using BS2p pin polling
' Author.... Jon Williams
' E-mail.... jonwms@aol.com
' Started... 05 DEC 2000
' Updated... 05 DEC 2000


' -----[ Program Description ]---------------------------------
'
' This program demonstrates BS2p polled-inputs and polled-out
' put control. Two pins are monitored and will control an out-
' put (alarm) pin. The interrupt condition is latched to deter-
' mine the cause.


' -----[ Revision History ]------------------------------------
'


' -----[ I/O Definitions ]-------------------------------------
'
AlarmLED  CON 0
FrontDoor CON 4                    ' front door input
BackDoor  CON 5                    ' back door input


' -----[ Constants ]-------------------------------------------
'
On            CON    1             ' LED is active high


' -----[ Variables ]-------------------------------------------
'
iPins          VAR    Byte          ' interrupt detect pins


' -----[ EEPROM Data ]-----------------------------------------
'


' -----[ Initialization ]--------------------------------------
'
Setup:
  POLLMODE 0                         ' clear and disable polling
  POLLIN FrontDoor,0                 ' interrupt when inputs low
  POLLIN BackDoor,0
  POLLOUT AlarmLED,On                ' alarm LED on interrupt
  POLLMODE 10                        ' latch interrupt condition


' -----[ Main Code ]-------------------------------------------
'
Loop:
  DEBUG Home,"Monitoring... "
  GET 128,iPins                      ' get cause of interrupt
  iPins = iPins >> 4                 ' move to lower nibble
  IF (iPins = 0) THEN Loop           ' no alarms

  DEBUG CR,CR                        ' alarm screen
  DEBUG "Alarm(s) Detected",CR
  DEBUG "-----------------",CR
  DEBUG "Front Door: ", DEC iPins.Bit0,CR
  DEBUG "Back Door:  ", DEC iPins.Bit1,CR

  PAUSE 3000                         ' give time for display
  DEBUG CLS
  POLLMODE 10                        ' reset polling
  GOTO Loop


' -----[ Subroutines ]-----------------------------------------
'
```

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USING VOLTAGE REFERENCE AND TEMPERATURE SENSOR ICs (Part 1)

by Ray Marston

Ray Marston shows — in this opening episode of this new three-part series — how to use various popular 'voltage reference' ICs.

This new three-part series looks at practical applications of various precision 'voltage reference,' 'current source,' and 'temperature sensor' ICs. Most of the ICs specified in the series are commercial-grade types, manufactured by National Semiconductor and various other companies, and are widely available; most of them are also made in 'industrial' and 'military' grades, with greatly enhanced specifications. This opening episode of the series deals exclusively with modern voltage reference ICs.

VOLTAGE REFERENCE IC BASICS

Voltage reference ICs are simple units that house a precision temperature-compensated voltage reference device and an output buffer stage. The reference can be of the 'band-gap' type, which generates a stable low-noise output of (usually) about 1.22V, or of the 'subsurface zener' type, which (in modern devices) usually generates a stable output of about 6.9V.

The output buffer acts as a current-boosting (and sometimes voltage amplifying) regulator, and may be of either the shunt or the series type. ICs with shunt outputs can normally be used in exactly the same way as a simple zener diode voltage regulator. *Figure 1* gives basic details of five popular 'commercial-grade' voltage reference ICs manufactured by National Semiconductor. Details of these five ICs are as follows:

Device number	V_{ref}	Voltage tolerance at +20°C	Drift PPM/°C (max)	Reference operating current
LM329B	6.9V	±5%	50	0.6-15mA
LM336B - 2.5	2.49V	±2%	54	0.4-10mA
LM385	Adjustable (1.235V-5.3V)	±2%	54	13μA-20mA
LM385 - 1.2	1.235V	±2.4%	150	15μA-20mA
LM385 - 2.5	2.5V	±3.0%	150	20μA-20mA

***Figure 1.* Voltage reference IC selection chart (National Semiconductor 'commercial-grade' shunt-output devices, with 0-70°C operating range).**

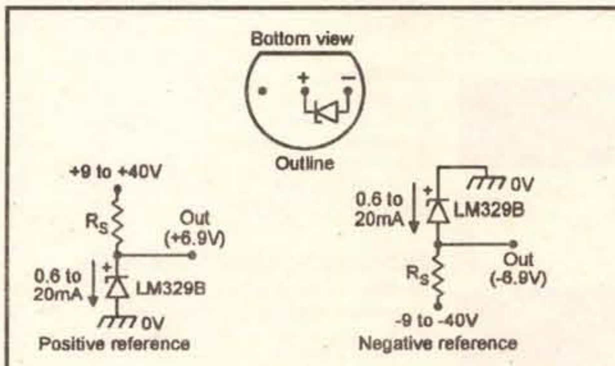


***Figure 2.* LM329B outline and basic reference circuits.**

The LM329B

The LM329B is a low-cost zener-based precision 6.9V reference that can operate over the full 0.6mA to 15mA current range. It is usually housed in a three-pin plastic package, as shown in *Figure 2*, which also shows basic ways of using the device as a positive or a negative 6.9V reference. In these circuits, the Rs value is chosen to set the desired operating current, as in a normal Zener diode. *Figure 3* shows a simple way of boosting the LM329B output via a non-inverting op-amp stage to make a 10V reference generator (a precise 10V can be set by trimming the *Cal* control).

The LM336B-2.5

The LM336B-2.5 is a low-cost band-gap based precision 2.5V (nominally 2.49V) reference voltage generator and is housed in a three-pin TO-92 plastic package; *Figure 4* shows the IC's outline

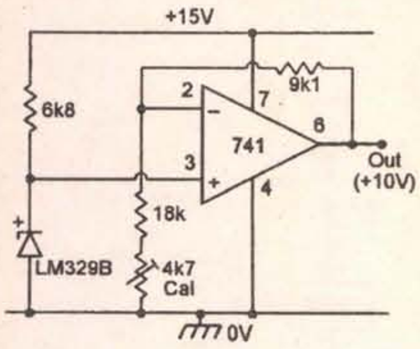


***Figure 3.* Buffered 10.0V reference with single-ended supply.**

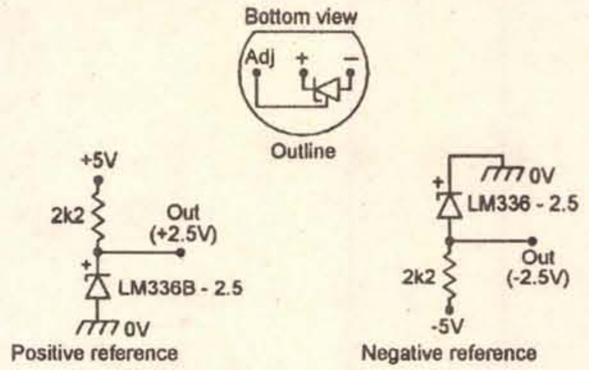


***Figure 4.* LM336B-2.5 outline and basic reference circuits.**

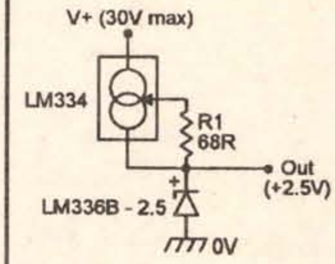


***Figure 6.* LM336B-2.5 voltage reference, using a wide supply voltage range.**

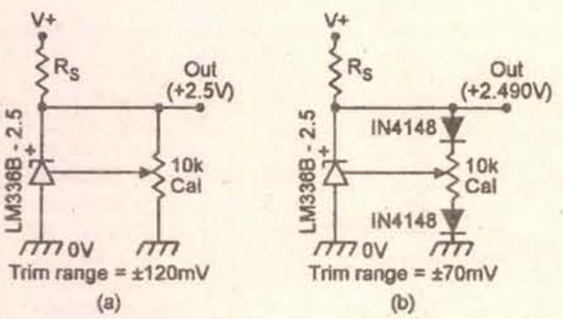


***Figure 5.* LM336B-2.5 'trim' circuits to give (a) voltage and (b) temperature coefficient compensation.**

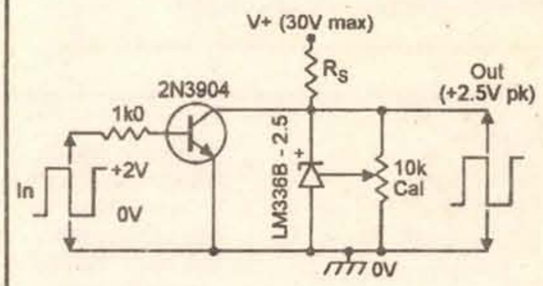


***Figure 7.* LM336B-2.5 squarewave voltage calibrator generator circuit.**

and basic usage circuits. The IC's third pin can be used to either trim the output voltage by about ±120mV, as shown in *Figure 5(a)*, or to trim the IC for minimum temperature coefficient (in which case, the output must be set to 2.490V), as shown in *Figure 5(b)* (where D1 and D2 must share the same thermal environment as the LM336B-2.5 IC).

Note that the LM336B-2.5 can be operated from a widely variable supply voltage (up to 30V maximum) by feeding it via an LM334 constant-current generator IC (described in detail in next month's episode of this mini-series), as shown in *Figure 6* (where R1 sets the constant-current value at 1mA).

Figure 7 shows how the LM336-2.5 IC can be used — in conjunction with an external squarewave generator — to make a squarewave 'voltage calibration' generator for use in oscilloscopes, etc.

In this circuit, the 2N3904 transistor shunts the LM336-2.5 IC, and is alternately driven fully on (saturated) and fully off via the external squarewave generator (which usually operates at 1kHz and can thus provide a 1mS timebase calibration function); the variable *Cal* control is trimmed to give an accurate 2.5V peak-to-peak squarewave output.

The LM385- series

The National Semiconductor LM385- series of ICs combine a band-gap reference and a shunt booster to make 'micropower' devices that can operate at currents ranging from a few microamps to 20mA. There are three basic devices in the series: the LM385-1.2 is housed in a TO-92 package and generates 1.235V output; *Figure 8* shows the ICs outline and basic application circuits. The LM385-2.5 is housed in the same type of TO-92 pack-

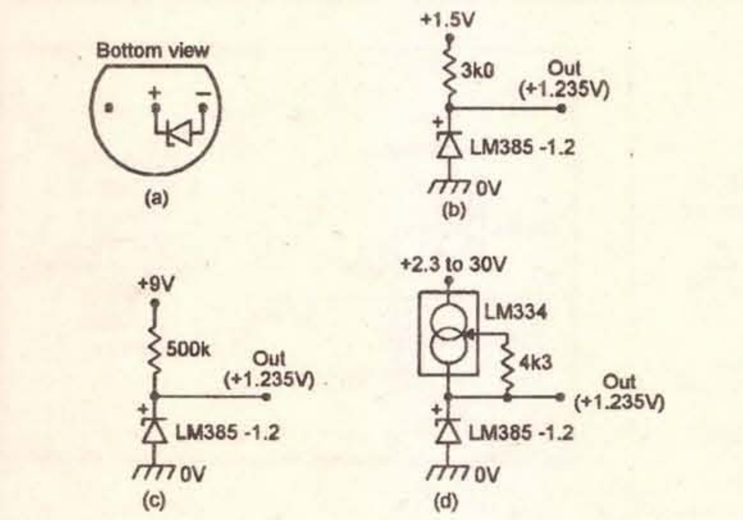


Figure 8. **LM385-1.2 outline (a) and basic circuits showing (b) reference from 1.5V battery, (c) micropower reference from 9V battery, and (d) reference from wide supply voltage range.**

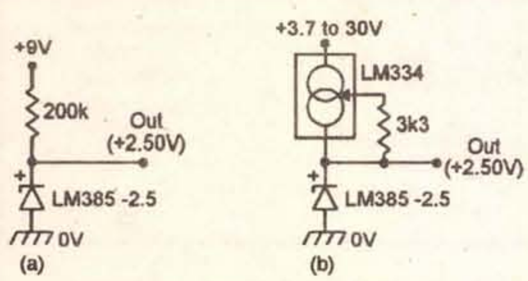


Figure 9. **Basic LM385-2.5 circuits showing (a) micropower reference from 9V supply and (b) reference from a wide-range supply.**

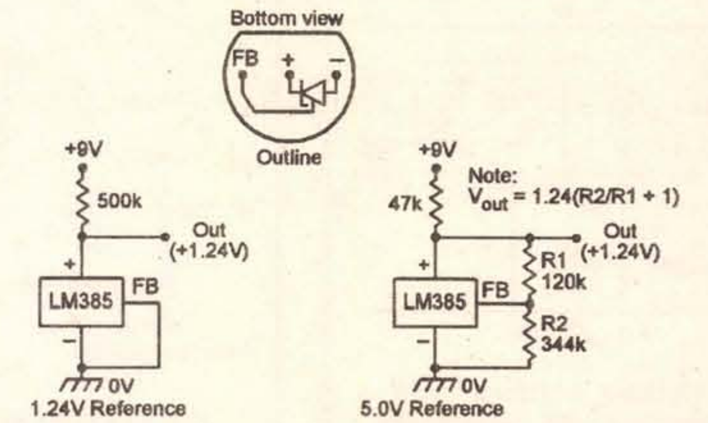


Figure 10. **LM385 outline and basic application circuits.**

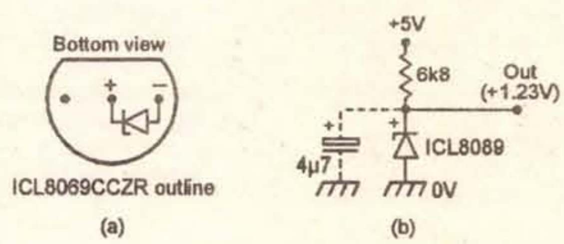


Figure 11. **ICL8069CCZR outline (a) and basic ICL8069 application circuit (b) as a 1.23V reference generator.**

age and generates a fixed 2.5V output; *Figure 9* shows two basic usage circuits for this IC. Finally, the plain 'LM385' is a three-pin version that can be adjusted, via its FB (feedback) terminal, to give a precision 'micropower' reference in the range 1.235V to 5.3V; *Figure 10* gives details of this device.

Note in the *Figure 8(d)* and *9(b)* circuits that the LM344 device is an adjustable constant-current generator IC, and will be described in some detail in Part 2 of this mini-series.

MISCELLANEOUS VOLTAGE REFERENCE ICs

Several companies other than National Semiconductor manufacture popular types of voltage reference ICs. Among the best known of these are Harris Semiconductor, SGS-Thomson, and Analog Devices. The remaining sections of this month's article briefly describe the most popular voltage reference ICs produced by these three manufacturers.

The ICL8069 (Harris Semiconductor)

The ICL8069 is a temperature-compensated band-gap voltage reference IC with a typical output voltage of 1.23V at an operating current of 500µA. The IC's operating current can be varied over the range 50µA to 5mA, and its output voltage typically shifts by only 15mV when the current is varied over this range. The ICL8069 is

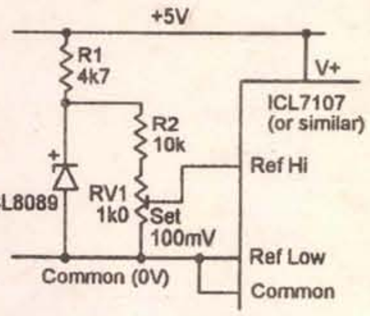


Figure 12. **Basic ICL8069 100mV reference generator for a DVM IC circuit.**

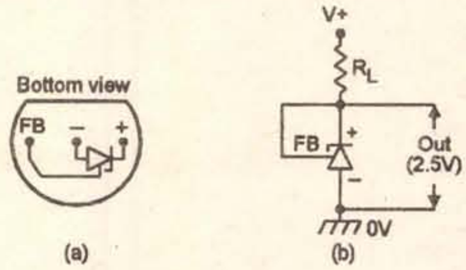


Figure 13. **TL431CZ outline (a) and basic application circuit (b) as a 2.5V reference generator.**

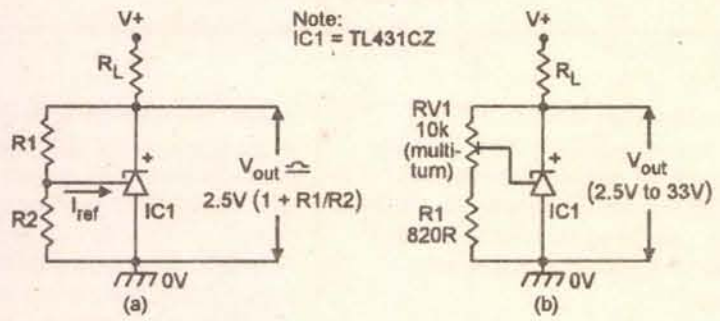


Figure 14. **Basic TL431CZ application circuits as (a) a programmable reference voltage generator and (b) a variable reference voltage generator.**

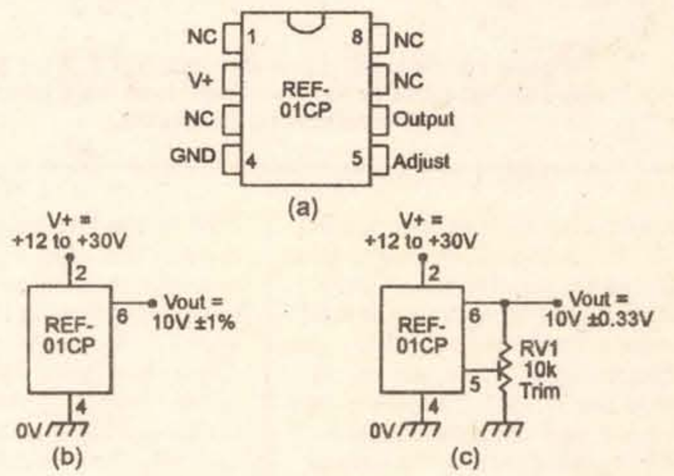


Figure 15. **Outline (a) of the REF-01CP, plus basic application circuits as (b) a fixed and (c) a trimmable 10V reference generator.**

produced in eight sub-types (each defined by a four-letter suffix). The best known of these is the ICL8069CCZR, which is housed in a TO-92 plastic package, can be used over the full 0 to 70°C temperature range, and has a typical output voltage temperature coefficient of 0.005%/°C.

Figure 11 shows the IC outline that is specific to the ICL8069CCZR, together with the basic application circuit that applies to all ICs in the ICL8069 range. This particular application circuit is designed for use with a 5V supply. The 6K8 resistor sets the IC's operating current at a nominal value of 550µA. The optional 4µ7 capacitor can be used to enhance circuit stability if the IC's output is loaded by capacitances in excess of 200pF.

Finally, *Figure 12* shows the basic ICL8069 IC used as a 100mV reference voltage generator for use in an ICL7107 (or similar) DVM (digital voltmeter) IC circuit. RV1 must be trimmed to set a precise 100mV output between the DVM IC's *Ref Hi* and *Ref Low* input terminals.

The TL431CZ (SGS-Thomson)

The TL431CZ is a temperature-compensated band-gap voltage reference IC with a programmable shunt output that can be set to any value between 2.5V and 36V via two external resistors. The IC is housed in a three-pin TO-92

USING VOLTAGE REFERENCE AND TEMPERATURE SENSOR ICs

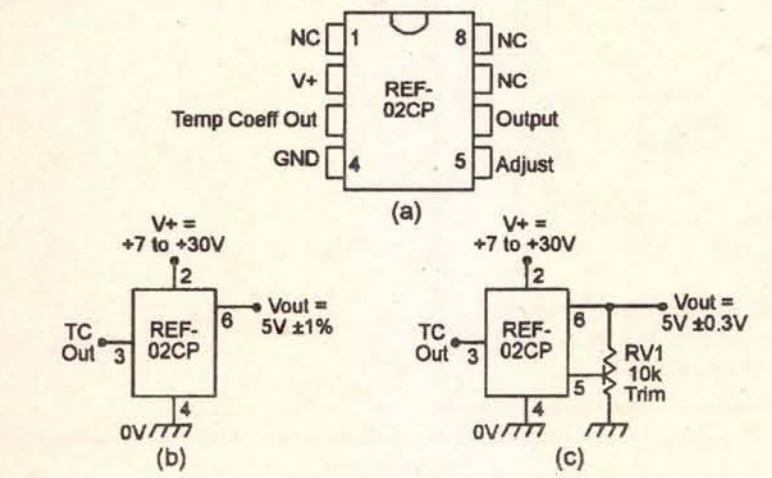


Figure 16. **Outline (a) of the REF-02CP, plus basic application circuits as (b) a fixed and (c) a trimmable 5V reference generator.**

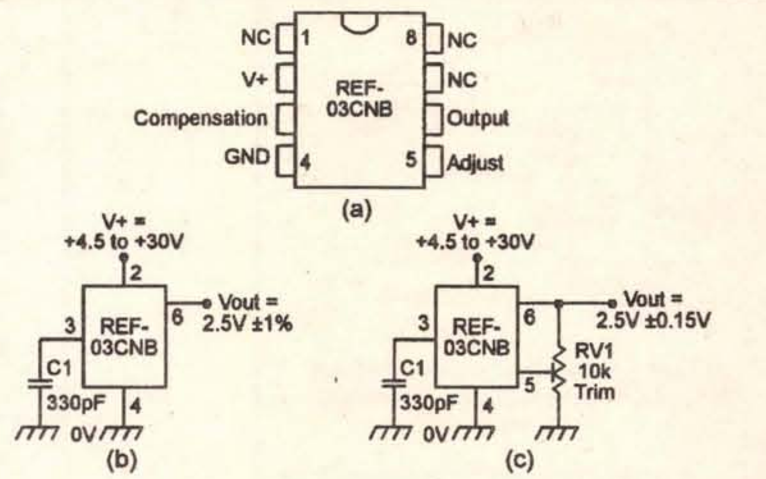


Figure 17. **Outline (a) of the REF-03CNB, plus basic application circuits as (b) a fixed and (c) a trimmable 2.5V reference generator.**

package, can be used over the full 0 to 70°C temperature range, and can (within sensible power dissipation limits) be operated at load currents in the range 1mA to 100mA. *Figure 13* shows the outline of the TL431CZ, together with its basic application circuit as a 2.5V (nominal) reference voltage generator.

Figure 14(a) shows how to use the TL431CZ as a programmable reference voltage generator in which the output voltage can (when the IC is powered from an adequate supply source) be set at any value within the range 2.5V to 36V via the R1/R2 potential divider. The basic V_{out} formula shown in this diagram is valid if the current flowing through the series-connected R1/R2 potential divider is at least 100 times greater than I_{bias}, which has a maximum value of 5.2µA (1.8µA typical). Thus, to generate a 10V output, R1 must equal 3xR2, and the R1/R2 combination must have a total resistance of less than 20K.

Finally, *Figure 14(b)* shows how to use the TL431CZ as a variable reference voltage generator, in which the output voltage is fully variable from 2.5V to 33V via multi-turn pot RV1. Note in both *Figure 14* circuits that the R_L value should be chosen to set the IC's operating current to 1mA or greater (0.5mA absolute minimum).

The REF-0x series (Analog Devices)

Analog Devices manufacture a variety of precision voltage reference ICs, the best known of which are their 'REF-0x' series of laser-trimmed band-gap devices with short-circuit proof outputs. There are three basic ICs in the series: the REF-01 type generates a basic output of 10V, the REF-02 type generates an output of 5V, and the REF-03 type generates an output of 2.5V. In all cases, the output voltage has a basic precision of ±1%; the output voltage can, however, easily be externally trimmed (by up to ±3.3% in the REF-01, and up to ±6% in the REF-02 and REF-03) via an external 10K pot. Note that the REF-02 provides a regular 5V output, plus an additional high impedance temperature-sensitive 'temperature coefficient' (TC) output voltage that changes linearly from 577.5mV at 0°C to 724.5mV at 70°C.

The REF-01, REF-02, and REF-03 are each produced in a number of sub-types (each defined by a multi-letter suffix), offering a variety of packaging and parameter options. The most popular of these ICs are the REF-01CP, the REF-02CP, and the REF-03CNB, which are each housed in an eight-pin plastic package, can be operated over the full 0 to 70°C temperature range, draw a basic operating current of 1mA, can provide up to 20mA of output load current, and consumes a self-limiting current of 30mA under shorted-output operating conditions.

Figures 15 to *17* show the IC outlines and basic application circuits of the REF-01CP, the REF-02CP, and REF-03CNB. In each case, diagram (b) shows the IC used in its basic (fixed output voltage) operating mode, and diagram (c) shows it used in the trimmable output mode. Note in *Figure 16* that the temperature-sensitive 'TC' output of the REF-02CP is provided on pin 3 of the IC. **NV**

Questions & Answers

TECH FORUM

This is a READER TO READER Column. All questions AND answers will be provided by *Nuts & Volts readers* and are intended to promote the exchange of ideas and provide assistance for solving problems of a technical nature. All questions submitted are subject to editing and will be published on a space available basis if deemed suitable to the publisher. All answers are submitted by readers and *NO GUARANTEES WHATSOEVER* are made by the publisher. The implementation of any answer printed in this column may require varying degrees of technical experience and should only be attempted by qualified individuals. Always use common sense and good judgement!

Send all material to **Nuts & Volts Magazine**, 430 Princeland Court, Corona, CA 92879, OR fax to (909) 371-3052, OR E-Mail to **forum@nutsvolts.com**

QUESTIONS

Don't forget to check out the new online electronics forums at the *Nuts & Volts* website. There are currently boards for discussing Robotics, Microcontrollers, Radio, Computers, and a General forum for discussing any electronic topic at all. We'll even add new dedicated boards for hot topics. Just let us know!

Want to get a jump on things before the magazine arrives? The Tech Forum questions are posted on our website on or before the first of each month. Unanswered questions from recent issues are there also.

I want to build a circuit to read AC current and DC current.

1. Current range: 0 to 200 amps, 115V/220V AC 60 cycles. Current range: 0 to 200 amps, DC.

2. Hook circuit to inputs of VOM with AC/DC current inputs 10 amp (VOM) + 20 amp (VOM) inputs.

3. Build its own circuit with built-in meter to read current AC/DC, no VOM.

1011 **Charles Whitman**
Ocala, FL

Is there an inexpensive way to input NTSC video into the USB ports on my computer? I don't recall seeing any articles in past issues.

I use my computer as a security monitor, but would like to 'watch' more than one camera.

The software program (Supervision Cam) vendor tells me that the program will monitor several cameras by just opening new 'configurations.' I was told that it will automatically open the 'next available' video input device.

1012 **Donald J. De Sario**
Akron, OH

I am looking for circuits that will convert a high-frequency smoke alarm siren to a low-frequency or wide (low-to-high) siren.

This is because many seniors (my father-in-law included) have high-frequency roll-off and cannot hear a smoke alarm.

The ideal circuit would be sound powered and simply attached to the external case of an existing smoke detector using a speaker/microphone pickup, but I'd consider AC/battery powered designs that would detect the siren of a detector going off and add additional amplified low alarm frequencies.

1013 **Thomas Dickson**
Molino, FL

I want to hook up a Jupiter GPS receiver to any microcontroller to read Lat/Longitude information. Can someone please tell me how to do that, or point me in the right direction?

1014 **Ray**
via Internet

I have a Realistic DX-300 which seems to have been "twiddled." I would like to realign the selector so it works in a somewhat linear manner, so it will agree with the dial. RadioShack doesn't have a clue as to where I can get a service manual, but does have a user's manual.

Since nothing is labeled this is useless unless I want a lifetime project tracing things out! No one on the Internet (that I can find) has a service manual either. I think it is Korean, but I don't remember who made it. Any suggestions?

1015 **David Pemberton**
Flagstaff, AZ

I've been trying to find a source for two unrelated parts for the past year and obviously need help.

1. A good used capstan motor for a Teac X-3 reel-to-reel tape recorder.

2. An IF xformer for the Heathkit BC-1A tuner (second IF).

1016 **Mitch Gembala**
via Internet

Is there an ISA card I can install INSIDE (not external receiver) my computer, that would perform the same function as a 4DTV Digital Satellite Receiver (made by GI), for my 16 ft. horizon-to-horizon antenna?

I know there's a PCI TV capture card with remote control, as well as an ISA FM radio card for Windows. So, why not a digital and/or analog satellite card, too?

I know there's an external satellite receiver which provides Internet directly from the satellite, but I'm just interested to get audio/video in digital/analog from a card, to be mounted INSIDE my computer. Can anyone tell me (and other interested N&V readers) of any firm manufacturing such a receiver?

1017 **Dan**
via Internet

I have a Philips model 1520ASES01 monitor that I would like to fix. I have checked a few web sites, but to no avail. Where can I get a schematic for this monitor?

1018 **Jeri McCord**
via Internet

ANSWERS

ANSWER TO #11002 - NOV. 2000

I need a schematic and parts list for a power supply from a McIntosh II si computer, model APS-06.

As you found, schematics for MacIntosh computers are nearly impossible to find. But there are still possibilities if you're trying to repair one.

The MacIntosh IIsi that you mentioned is old enough that it has very little value. You should be able to pick up a used power supply or even a whole computer for the money you'd spend on a Sam's schematic.

Try ebay or one of the used Mac dealers such as *Nuts & Volts* advertiser **Shreve Systems (1-800-227-3971 or www.shrevesystems.com).**

Doug Smith
Roscoe, IL

ANSWER TO #11004 - NOV. 2000

How can the 120V AC section of a motion detecting security light be eliminated, and the remaining 24V circuit be wired to run off a wall transformer?

The first thing that you will notice after you examine your circuit board in detail — after the transformer, after the bridge rectifier, and after the regulator circuit — is that the actual electronic components on the board don't operate at 120 volts, or even 24 volts, in almost all cases.

You need to trace the circuit past the step-down transformer and bridge rectifier, and even past this to the actual running capacitors or one of the chip's input (+) lead, to determine the actual running voltage.

Every motion detector that I have modified runs in the five-six volt range, but this doesn't mean that yours will run at this range, and may actually run at 12 volts or more.

ANSWER INFO

- Include the question number that appears directly below the question you are responding to.
- Payment of $25.00 will be sent if your answer is printed. Be sure to include your mailing address if responding by E-Mail or we can not send payment.
- Your name, city, and state, will be printed in the magazine, unless you notify us otherwise. If you want your email address printed also, indicate to that effect.
- The question number and a short summary of the original question will be printed above the answer.
- Unanswered questions from a past issue may still be responded to.
- Comments regarding answers printed in this column may be printed in the Reader Feedback section if space allows.

QUESTION INFO

TO BE CONSIDERED FOR PUBLICATION

All questions should relate to one or more of the following:

1) Circuit Design
2) Electronic Theory
3) Problem Solving
4) Other Similar Topics

INFORMATION/RESTRICTIONS

- No questions will be accepted that offer equipment for sale or equipment wanted to buy.
- Selected questions will be printed one time on a space available basis.
- Questions may be subject to editing.

HELPFUL HINTS

- Be brief but include all pertinent information. If no one knows what you're asking, you won't get any response (and we probably won't print it either).
- Write legibly (or type). If we can't read it, we'll throw it away.
- Include your Name, Address, Phone Number, and email. Only your name, city, and state will be published with the question, but we may need to contact you.

Regardless, you need to find this exact voltage and then *separate* the old power supply leads or trace coming in from the transformer, if possible, and simply attach a battery supply or wall transformer to this point to continue power to the board.

Where is this point? It will be different on each brand of detector sensor, but you need to find one of the large electrolytic capacitors [preferably] and tap in at that point with the new power supply.

In most cases, you don't have to actually disconnect or cut out the old leads because the bridge rectifier will isolate any reverse current but, if it doesn't, you will need to cut the trace or wire that causes a reverse drain.

The biggest problem that you will most likely encounter is that if you use an inexpensive wall power supply that doesn't contain adequate filtration, it will generate noise, glitches, spikes, and other components into the feed line that will spike your detector board and possibly trigger your sensor falsely or lock up the entire system. If this occurs you need to add standard filtration such as multiple capacitors, etc., to the power supply to reduce or eliminate these defects from your feed line.

I have found that a battery-powered circuit, followed by a trickle charging circuit eliminates most of these problems simply because the battery pack acts like a capacitor and filter that suppress most of these glitches.

Chris
Bieber, CA

ANSWER TO #110014 - NOV. 2000

I am working on a low-budget robotic system, and would like to use a buried wire or cable to guide the robot. I need to know a cheap way of building the hardware.

Connect an audio frequency oscillator to a speaker driver.

Physically separate the two conductors that would normally connect to the speaker.

Arrange those two wires in the form of a current loop. Part of the loop is the wire defining the path for your robot.

Keep the other part of the loop, the return part, physically well separated from the part that marks the path.

Run the audio oscillator at a frequency of 2,000 Hz, or higher.

For the sensor on the robot, you can use a small coil of wire. For example, use a telephone pick-up coil such as catalog number TPX-1 available from **All Electronics 1-800-826-5432**, for $1.50 each.

Your application may need two sensors, one on the left and one on the right side of the robot.

Steering information can be obtained by comparing the magnitude of the signals from the two sensors.

The **Jameco (1-800-831-4242)** function generator kit catalog number 20685 at $24.95 and the audio amplifier kit 125111 at $6.95 would give you the parts you need to "excite" the current loop.

The amp will drive an 8-ohm speaker; you may need a 10-ohm current limiting resistor in series with the current loop.

The pick-up coils are phase-sensitive. One coil should be arranged

ANSWER TO #12008 - DEC. 2000

I have two AM broadcast stations within a few miles and a very strong overload problem, specifically a 2a+b signal at 3.850 (smack dab in the heart of the 80-meter band).

How about a schematic or source for a highpass filter that cuts off the AM broadcast band? Since I am using a transceiver, it would have to handle about 100 watts.

How about a bandpass filter? It will clean up your transmitter signal, as well as reject the broadcast signals that are mixing in your receiver.

This design is a three-pole elliptic with redundant coil. The input and output impedance is 50 ohms. It will attenuate the broadcast band and transmitter harmonics 40 dB or more.

The schematic shows multiple capacitors, which are needed to handle the current at 100 watts transmitter power.

Five hundred volt capacitors would be okay, but the RadioShack 2KV units are inexpensive.

The coils are all #16 wire-wound on a one-inch form (see table). You can place the coils quite close together if they are at right angles to each other.

Since the capacitor tolerance is 10%, you will have to measure them and select the trim cap to come as close as possible to the values given in the table. Two percent tolerance will be adequate, but the closer, the better. The A and B caps are the same value.

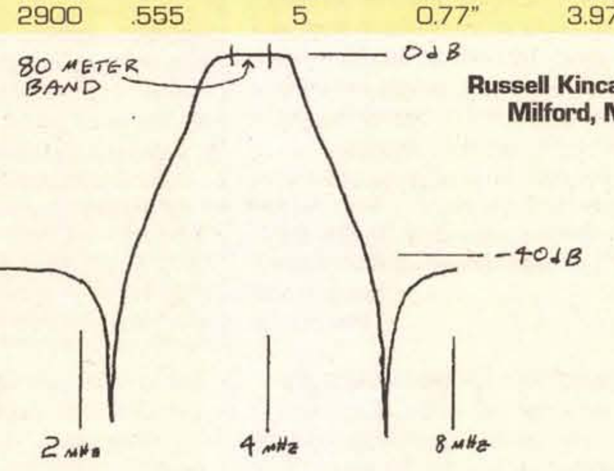
The coils are calculated to be the right value, but you will still have to adjust them by compressing or lengthening the winding.

The procedure is to connect the L and Cs (L1 and C1A, C1B + trim) to form a resonator, then use a grid dip meter or other means to find the resonant frequency. The desired frequency is listed in the table.

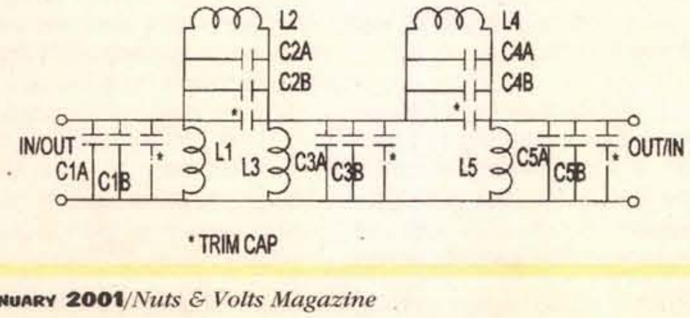
If you build the filter, but leave the junctions of L1 & C1 and L2 & C2, also L4 & C4 and L5 & C5 unconnected, then you can grid dip each coil without interference from the others.

Table

RES	A CAP	CAP pF	L uH	COIL TURNS	LENGTH	FREQ MHz
1	1500	3290	.631	5	0.62"	3.49
2	180	445	1.47	8	0.73"	6.23
3	680	1690	1.08	7	0.78"	3.72
4	470	1240	4.11	16	1.24"	2.23
5	1000	2900	.555	5	0.77"	3.97



Russell Kincaid
Milford, NH



*TRIM CAP

ANSWERS TO #11001 - NOV. 2000

I need a 7.8 DC power supply at 1 amp. Can anyone help me?

#1 If the power source is 110 VAC and you are not too fussy about regulation, then the quick solution is to call Jameco at 1-800-831-4242 and order the catalog number 127511 wall wart for $5.95. The rating is 1 amp at 8 VDC and it's even UL listed.

They have also a power supply kit, catalog number 177050, for $17.95 that might work, and if it didn't, you would learn how to build your own linear supply.

Or, if you want something to get the job done for sure, just call Ocean State Electronics at 1-800-866-6626 and order the variable supply Model XP-581 for $69.95. It can source 1.5 amps into 2.5 to 20 VDC, and has built-in voltage and current meters so you can watch what you're doing.

Jack Dennon
Warrenton, OR

#2 If you want a 7.8 volt DC one amp power supply, just buy a nine-volt one amp power supply and two one-amp silicon diodes. A diode drops .6 Volts across its junction, so two will drop the 1.2 Volts that you need to make 9 volts into 7.8 volts. Connect the two diodes in series with the positive lead of the power supply.

Any of the diodes 1N4001, 1N4002, 1N4003, or 1N4004 will work. The 1N4001 is RadioShack part number 276-1101.

The RadioShack Unlimited 9V power supply RSU 11327673 will work if regulation is not critical. Or you can use a well-regulated 13.8V supply such as MCM #72-6621 **(www.mcmelectronics.com)** and 10 diodes.

Rex Tincher
Kettering, OH

#3 Below is a circuit that should fit your requirements.

It is an adjustable voltage regulator circuit that utilizes an LM317T positive voltage regulator.

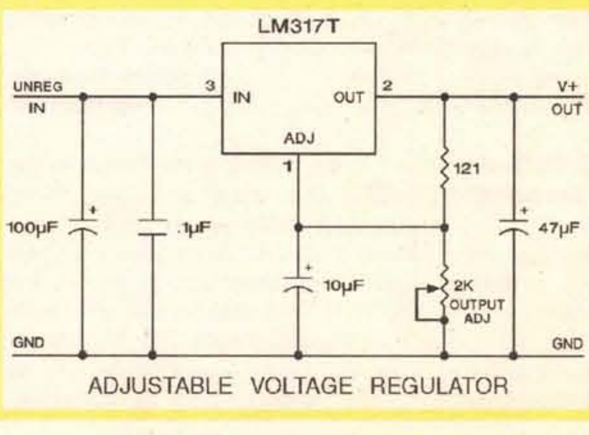
The suffix "T" on the part number designates a TO-220 "power tab" package, which the manufacturer specifies can supply in excess of 1.5 amps, when properly heatsinked.

Output voltage is adjusted by means of a 2K potentiometer.

For the most precise control of the output voltage, I would advise a high-quality, multi-turn pot. A pot such as this can be supplied by Digi-Key Corp. for about $3.00 (Digi-Key P/N 3299W-202-ND).

The LM317T is also available from Digi-Key for about $1.00 (P/N LM317T-ND).

A hint: keep the input voltage as low as possible (i.e., a couple of volts or so higher than your desired output voltage) to minimize the amount of heat produced by the regulator at full load, and don't forget to properly heatsink the LM317T.



ADJUSTABLE VOLTAGE REGULATOR

Jeff Burger
via Internet

upside-down with respect to the other coil. While they are at equal distances astride the guide wire, the signals they pick up will then be equal in magnitude, but opposite if phase.

As the robot wanders off track, one signal increases in magnitude while the other decreases. That implies that you could create your steering signal with a difference amplifier such as diagrammed, for example, on page 94 of Forrest Mims *Engineer's Notebook*, ISBN 1-878707-03-5.

For a single-supply amp you could use an LM324 instead of the LM741, because the lash-up that has been described is electrically similar to a well-known position transducer called a linear variable differential transformer (LVDT), the signal processing method called "synchronous demodulation," used with LVDTs, could be used.

Synchronous demodulation uses the signal from the exciter — the function generator in our case — to switch the error signal amplifier from inverting to non-inverting in step with (synchronized with) the excitation.

What happens is, while the positive-going half cycle of the sensor signal is in phase with the positive half cycle of the excitation signal, the amp is non-inverting and so the output is positive.

On the next half cycle, however, the exciter switches the amp to inverting, so the negative-going half cycle of the input signal becomes a positive-going excursion at the output. In other words, while the sensor signal is in phase with the exciter signal, the output is a positive-going full-wave rectified signal.

When the phase of the sensor signal shifts 180 degrees, all the input signal excursions become negative excursions at the output.

You can low-pass filter the amp output to create a steering signal.

The magnitude of the error signal tells you how far off track you are and its algebraic sign tells you which way to go to get back on track.

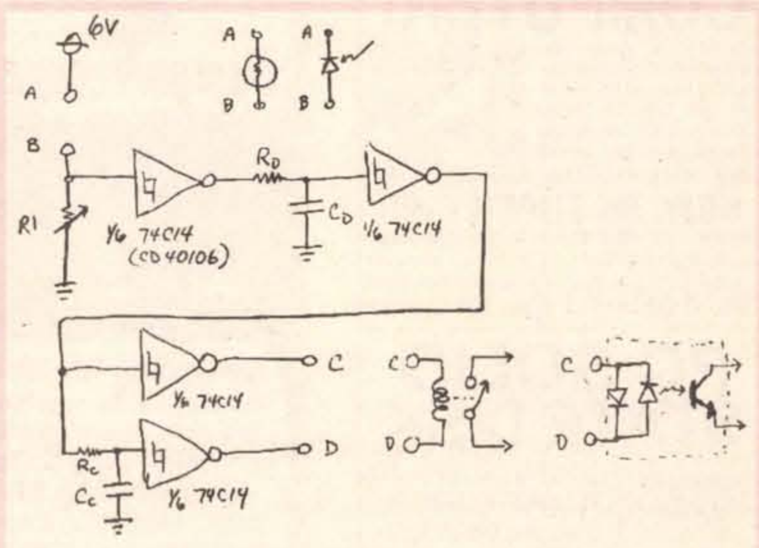
For LVDTs, **Analog Devices (www.analog.com)** makes some ICs that include both the exciter and demodulator in a single package.

Those ICs need split supplies, so you may still need to roll your own if you want to work with a single battery power supply.

Jack Dennon
Warrenton, OR

ANSWER TO #12006 - DEC. 2000

I want to build a DC six-volt photo cell timing circuit wildlife feeder that will feed dawn and dusk.



The circuit shown will activate a feeder mechanism. There are several options shown.

Stage 1. At the connections A & B (sensor connection points), either a CdS photoresistor can be inserted or a photodiode.

R1 can be adjusted to set the trip point between night and day. Set the trip point so it ignores cloudy weather and eclipses (just kidding).

The value of R1 will depend on the type of sensor selected.

R1 and the sensor act to develop a voltage that is presented to stage one of the 74C14 (CD40106). This is a hex-inverter chip with hysteresis.

The trip point is midway between ground and six volts. The 74C14 will work quite nicely with six volts.

As the light level increases, the voltage at point B will rise and eventually the output of stage 1 will go low.

As the light level drops, the output of stage 1 will go high.

Stage 2 (delay). The combination of Rd and Cd cause a delay. The output of stage 1 must persist approximately for Td seconds. Td is roughly the value of Rd multiplied times Cd. (This is the RC time constant.)

You will have to experiment to get the desired value. Example: a 220K resistor and a 40 uF capacitor will yield a delay of approximately 8.8 seconds.

Stage 3 (control). This consists of two sections of the 74C14 that detect changes from high-to-low and low-to-high.

The time allowed to activate the feeder is Tc and is determined by Rc and Cc. Again, Tc is roughly Rc multiplied times Cc. The output of the 74C14 with Rc and Cc always lags the output of the other 74C14.

Thus for time Tc, the two outputs, C & D, are opposite.

You can choose to put a sensitive five-volt DIP relay at points C & D or an opto-isolator with opposed LEDs.

These can then drive the feeder mechanism or a larger relay. Add a limiting resistor in-line with the opto-isolator.

These parts can be obtained at **DigiKey.com** or **Jameco.com** or any number of suppliers listed in *Nuts and Volts*.

If anyone wants further details, contact me at **wft@frii.com (www.wftelectronics.com)**.

Gus Calabrese
Denver, CO

ANSWER TO #11003 - NOV. 2000

Need a good source of single line array photo detectors (say three to four inches long by one pixel?) linear encoder?

Your question was very brief and your application was unclear, but I'll try to answer the best I can.

A very good source of CMOS optical linear arrays is **Texas Advanced Optoelectronic Solutions**. They offer a variety of highly integrated precision optical sensor products. They are at **www.taosinc.com**. Their web site has data sheets, application notes, and low-cost evaluation boards of their products.

You mentioned "linear encoder" in your question. CMOS optical linear arrays are usually low-resolution up to about 300 DPI.

If you are trying to do linear positioning down to 0.001 or better, your best bet is to use a linear quadrature optical encoder. You can probably get a good deal on a used one on ebay.

High-resolution linear image sensors are pretty spendy.

If you are doing high-resolution image sensing like a scanner-type application, your best bet is to get hold of a 1200 DPI or so scanner and scope the linear image sensor signals and figure out how it works and use a PIC micro to interface to the sensor array. Although this could take a long time, you learn a lot and it would be fun.

Shahrokh Jamshidpour
Bothel, WA

ANSWER TO #12007 - DEC. 2000

I am looking for a delayed paging circuit to record a message and play it back over a paging system.

It may not be worth the effort to design and build one. **Viking Electronics (www.vikingelectronics.com/)** has a store and forward unit designed specifically for PA use. It's part #FBI-1A.

Ed McCarron
via Internet

TECH FORUM

ANSWERS TO #12005 - DEC. 2000

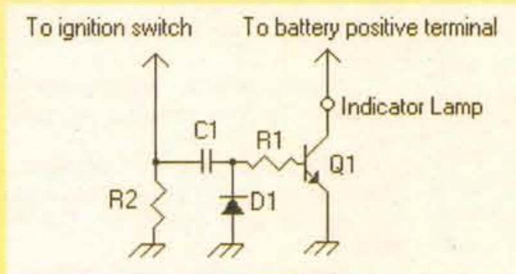
I restore old cars and I am trying to replace a 'seatbelt reminder' timer which is no longer available.

The timer should activate a 12V bulb for approximately 30 seconds and turn off. The simpler the better.

#1 This circuit can be used to light a seatbelt indicator bulb for about 30 seconds. It was designed without IC timers because simplicity was asked for.

C1 begins to charge when the ignition is turned on. It charges through R1 and the base-emitter junction of Q1. This causes Q1 to turn on and light the indicator lamp. As C1 reaches a full charge, the base current through Q1 decreases which, in turn, dims the lamp until it is extinguished. The lamp remains off.

When the ignition switch is turned off, C1 discharges through D1 and R2. After a few seconds, C1 is discharged and the cycle can be repeated.



C1 - 2200 μF 25V
D1 - 1N4002
Q1 - 2N4401
R1 - 22k ohm
R2 - 1.5k ohm

Jeff Scholz
Portland, OR

#2 The easiest, most elegant, and simplest solution to implement a seatbelt reminder timer is to use a low-cost Amperite "B" series time delay relay.

For the required voltage and timing as specified, the part number is 12C30B.

Amperite Co., Inc. is located in Union City, NJ and will take credit card orders over the phone.

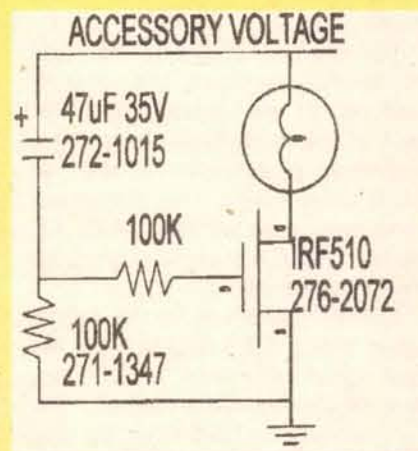
Their number is **1-800-752-2329**.

Anthony J. Caristi
Waldwick, NJ

#3 First, I recommend getting a used unit from an auto salvage yard. These are usually plug-in modules that are easy to replace. If that doesn't work out, this circuit will do the job.

All the parts are available at RadioShack, part numbers are given.

The turn-on voltage of the FET is not controlled, so you may have to use a larger capacitor for longer on time, or vice versa.



Russell Kincaid
Milford, NH

ANSWERS TO #12001 - DEC. 2000

I have a 10-year-old 27" color TV and the horizontal output is starting to sag.

When there are bright (especially white) areas on the right edge of the screen, the entire scan lines corresponding to the bright areas are shifted to the left.

When venetian blinds are displayed it looks very wavy.

Is this a case of "tired flyback?" Does age affect the coils or just the diodes?

#1 Before condemning the flyback, consider dried-out electrolytic capacitors in the horizontal driver stages.

Modern switching power supplies and video circuits give the electrolytics a real beating and, after 10 years, you are very likely to find a bad one. A bad electrolytic can reduce the drive to the horizontal output stage, and if the drive gets low enough, you can eventually destroy a horizontal output transistor.

Bad electrolytics in the power supply can put excess ripple on power branches throughout the set, causing all sorts of strange problems.

The best way to check the electrolytics is with an ESR meter. I use the Dick Smith Electronics model, built from a kit available directly from the manufacturer, which costs about $40.00, including international shipping.

Other good ESR meters are the Capacitor Wizard, available along with the Dick Smith model from Anatek's website at **www.anatek.com**, and the CapAnalyzer 88A offered by *Nuts & Volts* advertiser **Electronic Design Specialists**. Any of them will quickly pay for themselves if you do any regular service work on modern electronics.

A less precise way to check for dried-out capacitors is with your VOM. Look for the absence of a "kick" of the meter needle when you measure an electrolytic using the ohms scale, and keep an eye out for any brown, crusty material oozing from the rubber end seal of the capacitor.

Most radial-lead electrolytics are mounted flush to the PC board, making such otherwise obvious defects very hard to spot.

If you can slide the motherboard out of the TV, you can check all the electrolytics in about 20 minutes. No need to have a schematic or worry about which ones to test. I have repaired many monitors and TVs this way.

Flybacks do "age," but the usual problem is one where the focus changes during use as the flyback heats up, as there is a focus divider built into many of them.

Modern flybacks are very reliable (but not immortal!), so look for less costly causes of difficulty first.

Someone may wish to argue, but I have yet to see a diode in a properly designed power or video circuit which ever "aged" to some different parameter of operation. They either work or they don't.

Finally, lots of TV troubleshooting advice can be found on the web at **www.repairfaq.org**.

Geoff Fors
Monterey, CA

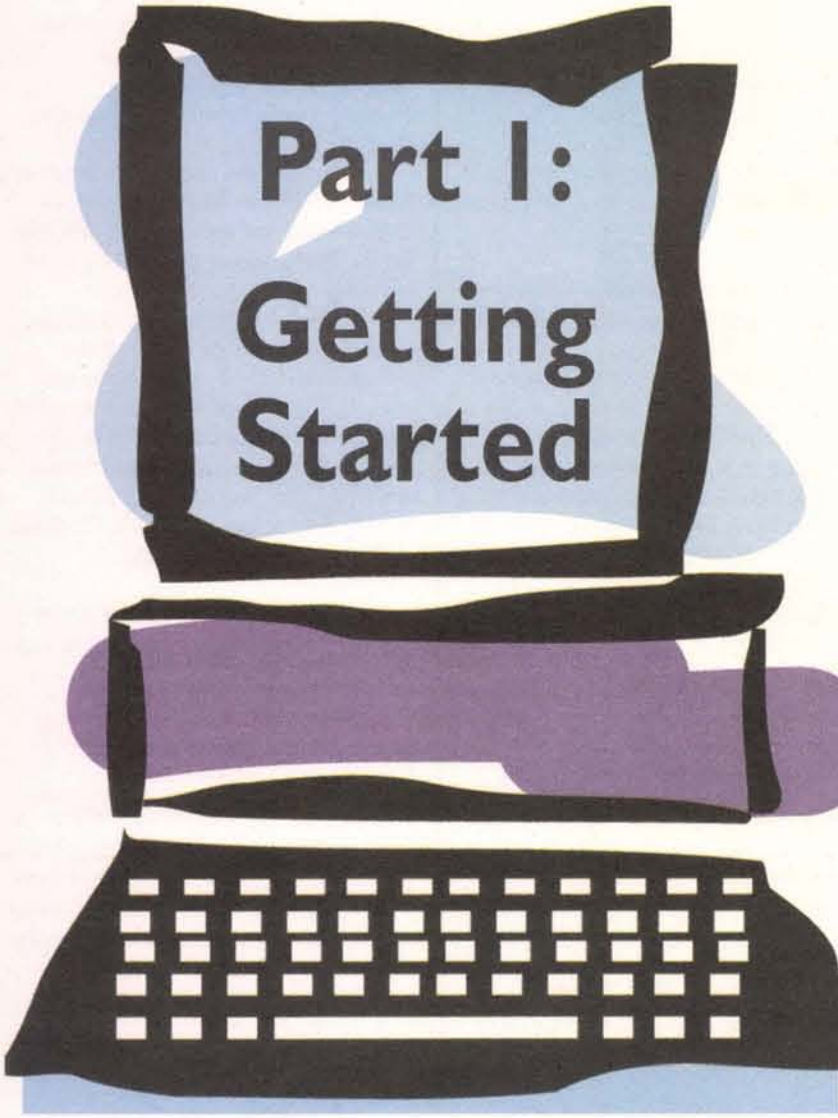
#2 It is likely that your picture tube is loosing brightness.

Over the years, you have been turning up the brightness to compensate, but now the current required to achieve normal brightness exceeds the output capability of the high-voltage supply, so the voltage is sagging. If this is the case, close examination will show that the lines in the picture are fuzzy, not as sharp as they once were. The solution is a new picture tube, not adjustment of the circuitry.

Russell Kincaid
Milford, NH

Cyber-Street Survival

by M L Shannon



Cyber-Street Survival is a series of six articles about privacy and security for people who are new to the Internet, or have not yet made the connection. In mostly plain English, it is written for computers that are not part of a local network. If you are on a networked computer, the System Administrator should be responsible for security. The programs reviewed here are for the Windows 95 and 98 operating systems. Some of them will also run on Win2K or NT.

Introduction

Any time you connect to the Internet, there is the chance that someone is keeping track of your movements through the World Wide Web — sending you files that are stored on your hard disk without your knowledge. Analyzing your Email, looking for certain key words.

Every time you log on, you may unknowingly be inviting spammers to bombard you with phony ads, get-rich-quick schemes, chain letters, and invitations for you and your children to visit pornography sites.

Each day, as you read your Email, you take the risk that a message may contain a virus that could wipe out every file you have.

Whenever you are online, there is the possibility that someone will be scanning you, looking for a way to invade your computer and install a Trojan Horse with which they will be able to take control of your system. Perhaps to see what's there, make copies of your files, or destroy information.

And most insidious of all, there are Internet stalkers out there on Cyber-Street who may be able to harass you, even steal your identity and impersonate you, which could have tragic consequences. Most data can be restored, but does your reputation and credit rating have a back-up file?

Why do these things happen? Because people make it easy.

The number of people on the Internet is increasing at a phenomenal rate, but many of these users know little about the net or the computers they use. And many of them are unwilling to take a few hours to make their machines secure against these attacks and abuses. Too lazy. Too busy. Or, they simply do not know how. And the heck of it is, too often they don't learn from a bad experience.

Most anyone who has ever had their home burglarized will take preventive measures to keep it from happening again. But this doesn't seem to apply to the Internet. Remember Melissa? And then along came 'The Love Bug' and the same thing happened. And it will happen again.

Some people are finally learning to lock their digital doors, but others go crying to the government to pass more laws to protect them. Which, they don't realize, is the antithesis of what the Internet is all about. Or was. Once, the Internet was a self-regulating entity. But now, because of all the abuse and the problems, government and big business are passing laws that say what we can and cannot do.

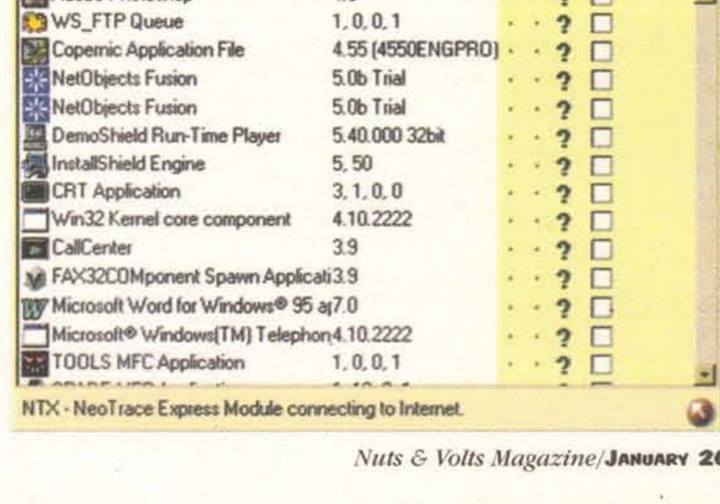
•

Welcome to Part I of the Cyber-Street Survival series. With the information here, you will be able to keep these things from happening to you. You will be able to surf the web anonymously so no one will know where you are coming from or where you have been. Encrypt your Email so that no one but the recipient can read it. Make your computer virtually invisible to potential "hackers." Keep your personal information private. Deal with unscrupulous marketing companies and reduce the amount of junk electronic mail — spam — you get.

You can also learn about some programs with which to trace spammers, find out who owns a web site and where they are, who is behind a banner ad, and other interesting things. You can install a 'packet sniffer' program that displays information entering or leaving your computer that you otherwise would not be aware of. And also a brief excursion into the murky and media distorted world of "Hackers."

No technical knowledge of either the net or computers is necessary to take advantage of what is here. Other than an Internet connection, you need only to be able to download and install software. The programs that are reviewed here will have step-by-step instructions, and there are links to many sources of FAQs (Frequently Asked Questions) and Help files.

However, as there is far more to write about than there is space for in this series. In Part 2, I will publish the address of a private message board, open to all *Nuts & Volts* read-



ers. There, I will provide additional information and answers to questions received by Email.

If you have not yet made the Internet connection, you may find the information at the end of this article of interest.

Getting started

Most of these articles will have a "hands-on" beginning; starting off with something you can do. This time, we will work on one of the most important things you can do to secure your computer against attack.

First, let's see how vulnerable your computer is. Go to Gibson Research Corporation at http://grc.com/default.htm. Scroll down to the dialog box that says Shields Up and click on Click Here. Now, move down to the button that says Test My Shields! and click it.

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The computer system this was written, produced, and typeset on is linked to, and part of, the electronic mail system, including but not limited to the Internet. Some of the material on this computer system, including all future editions and revisions, is being prepared, or was prepared for public dissemination and is therefore "work product material" protected under the First Amendment Privacy Protection Act of 1980 (USC 42, Section 2000aa). Violation of this statute by law enforcement agents may result in a civil suit as provided under Section 2000aa-6. Agents in some states may not be protected from personal civil liability if they violate this statute.

It will take a few minutes, then you will see what it says about Net Bios and Port 139.

You can read about what Net Bios is if you like, then use the Back button and click Probe My Ports! which tests the ports — 'doorways' into a computer — that are most likely to be attacked. It takes several minutes, and one at a time, the reports come in. If you have not yet done anything to protect your computer, you may find that some of these ports are open. A potentially dangerous condition that is explained.

Next, go to www.zonelabs.com and get ZoneAlarm. This program is a Firewall, free for personal use, which monitors attempts to connect to your computer and pops up a warning message. Download it to a directory of your choice, then use File and Run from Desktop and it will install itself. Restart your computer and it will load automatically. You will see a square icon, red and green, on the Task Bar at the bottom right corner of your screen. There are settings you can change and which are explained in the help file or at the Zone Labs site (shown in Figure 1), which you can experiment with later, but this is not required. It is already running and protecting your computer.

Now, go back to Gibson Research and run the two tests again. You'll see that the ports tested are now closed. Later in this series, you will read about another Firewall — ConSeal — which does more than just close these ports, it places them in 'stealth' mode so that when someone scans your IP address, they won't find anything. No indication that these ports even exist. But for now, it is important to close the port that Gibson probably found open.

Click on Start, then Settings, and Control Panel. In Control Panel, double click on Network. You will see a dialog box and near the bottom, a smaller box that says:

`File and Printer Sharing` and then:

`I want to be able to give others access to my files`

`I want to be able to allow others to print to my printer(s)`

Both of these selections have to be unchecked. Unless your computer is part of a network (directly connected to other computers), there is no reason for either of these to be enabled. They probably are checked by default, and this is one of the most dangerous port conditions you can have. To learn more about the Windows Networking settings, please see http://Cable-DSL.home.att.net/

Once this is done, restart your computer and reconnect to the Internet. Disable ZoneAlarm and go back to Gibson Research to repeat what you just did. You will see that the Net Bios port is now closed. You have just made your computer very secure against attack. More so than millions of other computers whose owners have done nothing. Later in this series, we will go into other types of attack using other ports, as well as attacks through Email. But for now, here are a few more important things you can do:

• If you receive any kind of an attachment to an Email message and you don't know for sure who it is from, don't open it. Copy it to a floppy disk for future reference if you like, and then delete it.

• If you are using your web browser — Internet Explorer or Netscape — for Email, STOP! Download and install an Email program such as Eudora Light or Pegasus, which are free and available at www.tucows.com. Then edit your browser so that your real name and Email address no longer exist. Web browsers can read things that are 'hidden' inside Email that is written in HTML (HyperText Markup Language), the language that browsers understand. More on this later in the series.

• Change the settings in Internet Explorer so that ActiveX is not enabled and in Netscape, disable Java Script. More about this in Part 5 on hacking.

• If you use Microsoft Outlook Express, you should know of the possible dangers. A good place to start is http://www.nwnetworks.com/iesecurity.htm. Some of the default settings are the reason that Melissa and The Love Bug caused so much misery. Better yet, don't use Outlook or Internet Explorer at all.

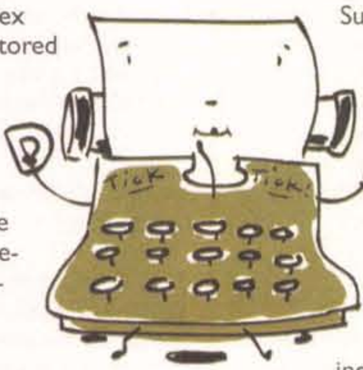
Now, let's have a look at some privacy issues and how to handle them.

INTERNET PRIVACY
Madison Avenue: Street without pity

It has never been a secret that marketing companies build databases of people for the purpose of persuading them to buy things. This has been true for many years, through junk

mail advertisements, questionnaires in newspaper 'Sunday Supplements,' telephone soliciting and, of course, television and radio.

Over a period of time, they were able to build a profile of you. Of your spending habits. Of what you are likely to buy or not buy. And when. This was a very tedious process. Information was typed onto index cards which were stored in filing cabinets in office buildings where you could still open the windows. Direct mail envelopes were addressed with adhesive labels or manually typed, stamps were licked and applied ...



And it worked. Direct mail was a success. People who received junk mail bought things. Billions of dollars worth of things. Records of their purchases were passed around to other marketing companies, profiles were honed to the point where various merchants were able to buy mailing lists of people who were very likely to buy their products.

Tedious work. Until the 70s when computers became so affordable that small businesses could purchase them. And now thousands of names could be entered into databases and sorted by category. Tens of thousands. Millions. Automated machinery folded the papers, stuffed them in the envelopes, printed the prepaid bulk rate permits, and sorted the letters by zip code. All bundled and ready to mail and all done by machines. And, while computers made it easy to process these millions of records, obtaining the information was still a tedious job because in the early years of computers, they were single individual machines that weren't connected to others. In order to share (trade, sell, give) these lists, bulky reels of tape had to be boxed up and delivered to the recipients.

Enter the Internet

A few years ago, the government decided that America should have an Information Superhighway. And it didn't take long for big business to realize that here was a system for gathering massive amounts of information about consumers. As the Internet exploded and hundreds of thousands of businesses went online, competition increased to get sales. More information was gathered, sometimes a great deal of it on any particular person, and sometimes information of a personal nature. Data Mining: the systematic looting of personal information on consumers and the selling and trading thereof.

Lotus' Marketplace: Home

With the development of the CD-ROM disk, it became much easier and less expensive to share this information and in November of 1990, Lotus (the software company) produced their ill-fated Marketplace: Home. This set of CDs, which cost about $600.00 contained details of 80 million American households. Public reaction to the idea of anyone being able to purchase these disks was considerable, and Lotus was forced to drop the project.

Janlori Goldman, a staff attorney with the American Civil Liberties Union, stated "This is a big step toward people completely losing control of how, and by whom, personal information is used." And she added that the product raises "serious legal and ethical questions." And so Lotus didn't go to Marketplace. Instead it cried wee wee wee all the way Home.

Now, let's consider some of the ways marketing companies get their data from the Internet.

Log files

Whenever you connect to a web site, you leave behind a certain amount of information about yourself. This may contain any or all of the following:

- Your IP address.
- Date and time you logged on and how long you stayed; the length of your visit.
- What areas of the site you viewed and the sites you were previously visiting.
- The type of computer you are using and operating system (Windows, Mac, Linux).
- The Internet Service Provider where your account is and the city it is located in.
- Any words you used to make a search to find the site.
- Your real name and Email address.

Forms

Every time you fill out a form at a web site, you give away information about yourself and perhaps your family. Now you may see something called a Privacy Statement in which you are assured that your information "will not be sold." Perhaps not. But it may be 'given away,' in exchange for similar information from another marketing company. Traded, in other words. Or loaned. Or rented.

Banner ads

Banner ads are on practically every web site you visit. And they are not as harmless as they may seem. Clicking on them can also provide information about yourself.

"How many times has your heart beat in your lifetime?" You are curious, so you type in your day, month, and year of birth. Your web browser may have already told the company that placed this banner your name and Email address, and now they have your birthdate. Meanwhile, a cookie (explained later) has been placed on your hard disk drive, which you may not have known about, and the next time you log onto that site, you see banner ads oriented towards people of your age group.

Okay, big deal, you say. So what? Another banner ad implies that the company behind it is concerned about your health. They have a nifty little chart where you enter your height and weight to see if you are

IP Basics

To use some of the software in these articles, it is necessary to understand the basics of Internet addressing. Just as every telephone has a unique number, every computer on the Internet has a unique address. This is known as its IP or Internet Protocol address and is represented as a series of digits. Yahoo, for example, is 216.115.106.235. These numbers are what Internet equipment uses, but humans are more comfortable with names. So, we have what are known as DNS (Domain Name) servers which translate one to the other. You want to use your browser to read the news, you type in www.yahoo.com and a DNS server somewhere, probably at your Internet Service Provider, does the translation, and the connection is made. This also applies to extensions other than dot com, such as dot org, dot net, dot edu, and dot gov.

Note that IP is also used here to indicate the Internet Provider address; the particular IP that you are using when connected to your Internet Service Provider.

within certain standards You'll probably lie by at least a few pounds, but still, this is one more thing "they" know about you.

Another banner wants to know what kind of car you are thinking of purchasing. Now they have a good idea of your income bracket.

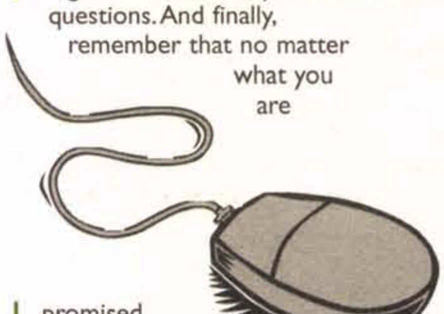
Yet another banner ad expresses concerned for your health, so they make it easy to "find a doctor near you." To provide the location, they want your zip code. Marketing companies are really big on zip codes. They have sophisticated databases and charts and diagrams that tell them how many people live in a given zip, the average income, type of housing (homes or apartments), real estate values, occupations, vehicles owned by make and value ... And don't forget, by knowing what kind of doctor you require, they now know something about your medical history.

Banner ads offer to get you "guaranteed low interest loans" but you may have to type in your Social Security number. Now they know virtually everything about you — since technically you have applied for credit, they can access part of your credit history file called a 'Header.'

Yahoo runs banner ads offering an easy way to pay all your bills. Online. Consider: You are sending out a list of your debts, amount of monthly payments, donations you make to political or charitable organizations, and of course, your bank name and account numbers.

An exercise

Spend a few hours roaming around, checking out various sites and look at the banner ads you find. Then think about what details of your life might be revealed if you answer their questions. And finally, remember that no matter what you are



promised about privacy and confidentiality, when you hit the Enter key, you are sending information out onto Cyber-Street, and you have no control over where it ends up.

Ad blockers

A number of programs have been produced that automatically block these ubiquitous ads. I tried several of them and while all of them are good, I am partial to Ad Filter. It is small (less than 500K), installs in seconds, and doesn't have to be used as a Proxy (more about Proxies in Part 2). It is versatile in being able to select what you do and do not want to be blocked, including web bugs and cookies, those damned 'pop-up' ads you see on AOL and Tripod, and also some kinds of "Adult" material. Three programs in one. Configuration takes all of five minutes.

An excellent program that does exactly what it claims to do. Registration is only $24.95 and an evaluation version is available at http://www.adfilter.com/info.html.

Another great little program is Zero Click available free at www.privsoft.com. It blocks banner ads and cookies from DoubleClick, one of the big names in these nuisance ads. "... You'll never see their banner ads, you'll never get their cookies, and your machine cannot send DoubleClick any information. DoubleClick ceases to exist ..."

Cookies

A Cookie is a small file that contains information about you, and, unless you block it, is placed on your hard disk drive. Now, this information may be used only at the site that placed it there. You visit that site again, their computer reads the cookie and has an idea of your interests. What areas of the site you visited before. And, using that, it can take you directly to those areas. In other words, all cookies are not necessarily "bad," they may be a convenience to their visitors.

However, some cookies — 'Third Party' — don't stay at that site. They are sent to marketing companies that have deals with thousands of sites, to forward this cookie information to them.

Log on to a web site and watch the Status window at the bottom of the browser screen. As it is loading, you will often see the names of well known companies flash by: DoubleClick of course, also Flycast, GotoNet ...

Jason Catlett, President of Junkbusters Corp., said "Cookie leaks are the bug from spammers that keeps on bugging. It's intolerable that Email can be used to silently zap a nametag onto you that might be scanned by a site you visit later. It's like secretly barcoding people with invisible ink."

What does a cookie look like?

Just a collection of letters and numbers that don't mean anything except to the site that placed it. Here is one example from Link Exchange:

```
LE_COOKIE
1.2a.a8beefc6978d70c43c39d70a
fb045b348d9674c2d3953b50e7ddcb6
e026bfa59d0fa24c075a8b948cc7b0ed
6cf4e1dd358698a00c8069db0
linkexchange.com/
0
2678203648
29734687
3659076032
29367358
*
```

What you can do

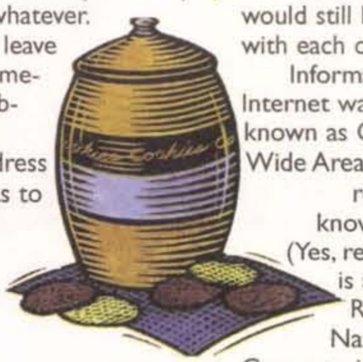
As mentioned above, don't use your real name or Email address in your web browser. If you install Netscape, you are required to create a User Profile. If you are like most people, you probably don't know any better. You may have decided to use it for your Email, but this makes it easy for marketing companies to get your address and add it to their dossier. And then you start getting unsolicited junk mail. Spam. And also junk snail mail. I registered online for admission to a computer security conference, including my post office box for the ticket, and for several months after, I received literally hundreds of offers to subscribe to this or that magazine or newsletter, attend this or that convention, and enough catalogues to impress someone you will read about in Part 2.

But I didn't get any spam because I didn't use my real Email address, and

There are very few situations where you should use your Social Security number online. Whoever asks for it, if they are legitimate, will also provide you with an address to where you can snail mail it. Or a fax number. If they refuse, then maybe you should refuse. Matter of fact, any web site that does not have a mailing address and phone number should be suspect.

I contacted the site through a proxy program that hides my IP address. This program — A4Proxy — will be reviewed in Part 2.

So, if you are using Netscape, create a new Profile. Don't use your real name. Call yourself Sally Sikorsky or Joe Jacovitz, or whatever. For an address, just leave it blank or enter something like joe43@flibberdygibbit.com. In other words, an address that doesn't exist. As to the old Profile, you can't delete it, and reinstalling Netscape won't get rid of it, so just ignore it



While you are at it, set Netscape so that it does not accept cookies. Okay, some sites will refuse to let you connect, and unless it is really important that you do, then just leave. Whatever you can find at one site, you can probably find at another. If you have no choice but to accept the cookie, then delete it after you move to a different site. If you are using the Opera web browser, you have the option of selectively blocking third party cookies that go somewhere other than the site you are presently visiting. Opera also offers the ability to delete cookies when you close it or disconnect from the Internet. You can get Opera at www.tucows.com. It has a free trial period and registration is $40.00.

Dog Cookies

Scottie loves cookies. He loves to eat them.

Scottie is a little black dog who sits faithfully on the taskbar at the bottom of your monitor screen and sniffs at things periodically. If a new cookie is received, 'Arf-Arf!' Scottie pops up to warn you. Scottie is part of a really neat little program called WinPatrol available from winpatrol.com. Nifty and useful and best of all, it is completely free.

Now, some Internet basics for those of you who are not yet online.

Origins of the Internet: A brief history

The Internet, which is not the same thing as the World Wide Web, is a massive system of millions of computers, routers that process information to see that it gets where it is supposed to go, gateways that connect different types of networks together, satellites, microwave relay towers, fiber optic cables, and ordinary copper telephone lines. "Cyberspace." It began life in the 60s as DARPANET, the Department of Defense Advanced Research Projects Network. Access was limited mostly to government facilities, colleges and universities, and research laboratories. They were connected together in such a way that if one facility were disabled by a nuclear attack, all of the others would still be able to communicate with each other.

Information stored on the early Internet was placed in repositories known as Gophers and WAIS, or Wide Area Information Service. To retrieve these files, tools known as Archie and Veronica (Yes, really!) were used. Veronica is an acronym for Very Easy Rodent Oriented Nationwide Information Computerized Archives. And to answer your question, yes, there was also a Jughead which stands for Jonzy's Universal Gopher Hierarchy Excavation And Display. Another tool was Telnet, which you can read about in a future article.

These applications were command line driven; everything was typed in manually. There were no icons to click on, and nothing to click with. The 'rodent' in Veronica was the Gopher. The mouse had not yet been invented. The significance of this is more than just historical — there are still information sources that cannot be accessed through the World Wide Web and which require other programs than a browser. Such as File Transfer Protocol (FTP) and Telnet.

A few years later, CERN Laboratories in Switzerland created a new system for transferring information called HyperText Transport Protocol, and a graphical program called Mosaic. Thus began the World Wide Web.

Getting connected: Internet connection or proxy?

A true Internet connection, through a company called an Internet Service Provider (ISP) means that once you connect, you become a part of the Internet, a 'node' with your own unique IP address. Another type of service is known as a 'proxy.' You remain connected to the computer that answered and access the Internet through that computer. America OnLine, for example, is a proxy server.

The difference may seem transparent at first, but after you have been online with a proxy, you will see that there are limitations and restrictions that you may not want to accept. Some of the software reviewed here will not function. In which case, you can open an account at a true ISP of which there are thousands. Some are listed in the trusty Yellow Pages.

Dial-up, cable or DSL?

Dial-Up, or PPP (Point to Point Protocol) accounts use a modem connected to an ordinary telephone line and are limited in transfer speed to about 40K per second. DSL — Digital Subscriber Line — also uses the telephone line but with a different type of modem. The transfer speed will vary, but it can be about 40 times as fast as PPP. Cable, naturally, requires that you have cable installed in your home or office. Transfer speed is similar to DSL. If you decide on either cable or DSL, ask the installer what your IP address will be, and if it is Dynamic a list. Also get the IP of the Name Servers as you will need them in Part 6.

Security of your connection

There is some debate about which type of service is the most secure. There isn't enough space to go into the details, but if you use the software and techniques in these articles, it really doesn't matter. If you have a choice between cable and DSL, you might read up on both. In which case, you may well decide DSL is the way to go. There are excellent articles in *PC Magazine*, and *WIRED*, as well as local magazines available at most newsstands.

Software you will need

When you install Windows, you automatically install Internet Explorer. There is no way to avoid this. (That's what the big lawsuits

against Microsoft are about.) So, IE will get you started, and then you can download other programs such as Eudora for Email, and Opera for the WWW.

Dial-up adapter

To make the connection, Windows has a routine called Dial-Up Adapter. In Win 95, it was a bit tricky to set up, but with 98 it is much easier. The people at your ISP will be able to explain the settings you may (or may not) need to make such as the IP for their name servers (more on this coming up) and a few other things.

If you are getting DSL or cable, the service providers will provide assistance if needed. **NV**

Credit where credit is due ...

"Seuss" who has provided much useful information.

Steve Uhrig of SWS Security for many things including proofreading and encouragement.

Thanks to Timothy Walton, a San Francisco Bay Area Internet attorney, for his help with understanding civil law; especially Small Claims Court.

The producers of the software reviewed here for permissions and advice on using them.

A security expert, one of the best, who will remain unnamed as he likes to keep a low profile.

Next Month

Part 2 will be devoted almost entirely to spam — the Internet equivalent of junk mail. What it is, what you can do about it, and the easiest way to deal with it: Just Say Delete. Also, the basics of how to trace spammers, should you care to.

Parts 3 through 6 will be about Email, Data Encryption, Hacking, Stalking, "Cyberporn;" pornography on the Internet and IP Tools used for tracking spammers among other things.

Several programs will be reviewed here on Cyber-Street. A Packet Sniffer with which you can see all of the data that enters and leaves your computer. A Proxy program with which you can explore the Internet anonymously; without leaving a trace behind you. A suite of IP tools. A Port Scanner to use for testing the security of your computer against attackers. And, as you will be working with files, the best file utility ever produced. This is Z-Tree Gold which you can get at **www.ztree.com**.

Some of these programs are in compressed, or 'zip' form. To extract them so that they can be installed requires a program such as Winzip, available at **www.tucows.com** or **www.winfiles.cnet.com**.

I will be setting up a Bulletin Board for *Nuts & Volts* readers who have questions about the content of these articles. They cover a lot of material and because of space limitations cannot be as detailed as will be in my Cyber-Street book, scheduled to be published this year.

New Product News

PROGRAMMABLE INDUSTRIAL CONTROLLER

For those working in the industrial environment, Digital Design Solutions, Inc., annouces the release of a Programmable Industrial Controller ala PLC Style, which interfaces with 24-volt input and output devices using the ever versatile BASIC Stamp module.

All inputs are opto-isolated allowing for a good deal of flexibility. The eight inputs are easily configured to use with both flavors of industrial 24-volt sensors both PNP and NPN optical photo sensors or proximity sensors.

The inputs will also accept switches or contacts, various photo transistors, and Hall-Effect sensors with open collectors. Input sensors derive their power from the four terminal input connections. Thus, there is no need to assemble a large section of DIN rail terminal blocks to distribute power to sensors. A DIN rail fuse block is recommended to power up this module.

TO-92 Darlingtons are used as open collectors on the eight outputs (500 mA capacity nominal for outputs) with flyback diodes on the board for protection against inductive spikes when coupled with pneumatic solenoids, relays, or motors.

Other features include a five-volt switching regulator. This results in high efficiency and low heat when converting from 24 VDC to five volts with a 1.5 amp capacity at five volts, should one wish to use a power-hungry VFD display with this module.

An LCD output connector is configured for a pin-to-pin mate with a serial LCD backpack interface.

This 8x8 controller comes with a DIN rail mountable plastic holder ready for your application. Just add power, a BSII or BSIIe, your sensors/outputs, and some programming to have your industrial solution up and running for a lot less money than an equivalent mini PLC.

The fully assembled controller with DIN rail mounting is available for $289.00.

For more information, contact:

DIGITAL DESIGN SOLUTIONS, INC.
1937 HYDE DR., DEPT. NV
LOVELAND, CO 80538
970-667-4239
EMAIL: ronaldsa@earthlink.net

EVS-1 ELECTRIC VEHICLE SYSTEM

The EVS-1 is a complete electrical system that makes it easier to build your own electric bike, scooter, train, etc.

All wiring, connectors, and harnesses are provided pre-wired. It includes everything you need to get your EV up and running except the batteries and motor(s).

The EVS-1 can also be used to upgrade an existing electric vehicle (EV) from a 12- to 24-volt system.

The following component parts are included:

(1) A compact uni-directional controller rated at 24 volts, 20 amps continuous (80 amps for one minute) with protective cover. (An optional bi-directional controller is available that can provide up to 35 amps of continuous current.)

(2) A 24- to 12-volt power converter to operate 12-volt accessories such as a headlight and horn.

(3) A radio-controlled anti-theft device which disables the EV until it receives a signal from a keychain-mounted transmitter.

(4) A five-foot main harness assembly connecting front and rear electronics and controls, and all other necessary interconnecting harnesses.

(5) Handlebar-mounted module with an on-off switch and a thumb-operated, spring return throttle control for full stepless speed from 0 to 100%.

(6) Dual front PC boards mountable in a housing of your choice – one serves as a cable interconnection board and the other has two bargraph LED displays which allow you to monitor battery voltage and current use.

(7) Handlebar-mounted module with switches for headlight and horn.

(8) High-current wires needed to connect to the motor(s) and batteries.

The complete system, with all parts connected together and with documentation detailing the connections is priced at $100.00.

For more information, contact:

DIVERSE ELECTRONIC SERVICES
1202 GEMINI ST., DEPT. NV
NANTICOKE, PA 18634
570-735-5053
EMAIL: carlk3jml@bigfoot.com
WEB: http://divelec.tripod.com

SECURITY CAMERA WIRELESS TRANSMITTERS

The Security Camera Wireless Transmitter series – a line of compact battery-operated transmitters that connect to surveillance cameras and send live video streams to any TV or VCR within a 200-foot range.

Compatible with virtually any powered surveillance cameras, these transmitters are perfect for monitoring exterior or interior cameras from another room without having to run coaxial cable throughout your home or office!

The transmitters are available in two versions. The 900MHz model offers superior signal strength, and is perfect for long-range camera monitoring in areas that are prone to interference. It sends signals to a dedicated receiver designed to enhance signal quality.

Two different receivers are available (each sold separately). The 7647F is a stand-alone receiver, which can be connected to the audio and video inputs of a TV for direct viewing or to a VCR for surveillance taping. The 7647H is a combination 900MHz receiver and 7" black and white monitor all in one unit. Additionally, it has output jacks to send its signal to a VCR for surveillance taping. Both receivers include AC-to-DC power adapters.

For truly portable and wireless surveillance, the 434MHz model sends signals directly to cable channel 59 on any TV or VCR with a standard VHF antenna. No dedicated receiver is necessary! Just set your TV or VCR to the cable mode, tune to channel 59, and you'll be able to monitor or tape live video images from up to 200 feet away.

Both transmitters require a standard nine-volt battery. Battery life with a standard nine-volt battery is 10 hours.

The Security Camera Wireless Transmitters are only $257.90

For more information, contact:

LORD & WYATT COMMUNICATIONS, INC.
147 HALSEY ST., DEPT. NV/DSM
BROOKLYN, NY 11216
718-789-7328, ext-12
FAX: 718-789-7329
EMAIL: AtHomeThings@aol.com
WEB: www.AtHomeTechnology@.com

Showcase your New Products here! Send all press releases or information/photos to:

Nuts & Volts Magazine
New Product News
430 Princeland Court,
Corona, CA 92879
or E-Mail to
newproducts@nutsvolts.com

QUIKLINK™ PRIVATE WIRE AUTOMATIC RINGDOWN UNIT

Quiklink™ private wire automatic ringdown unit provides instant off-hook access between two telsets in a tiny package at a lower cost than any existing product.

The unit is powered from either a 12 VAC wall adapter or 24-48 VDC supply.

Three models offering selectable cadences cover every budget and technical requirement.

Monolithically encapsulated units may be PCB-mounted as a single component in OEM applications, in addition to traditional use as a stand-alone telecom device.

The unit's size is only 5/8 x 4-1/4 x 2-1/2 inches, six ounces.

Quiklink's price is $75.00.

For more information, contact:

CAMBRIDGE ELECTRONICS LABORATORIES
20 CHESTER ST., DEPT. NV
SOMERVILLE, MA 02144-3005
617-629-2805 FAX: 617-623-1882
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